

PREFACE

Agricultural Finance Review provides a forum for presentation of research and discussion of issues in agricultural finance. Publication is annual, and all articles are contributed by scholars in the field. Articles on assigned topics may be commissioned occasionally.

Volume 43 was the first to be published at Cornell University. The previous forty-two volumes were published by the United States Department of Agriculture. AFR was begun in 1938 by Norman J. Wall and Fred L. Garlock, whose professional careers shaped much of agricultural finance research for many years. Since that time, professional interest in agricultural finance has continued to grow, involving larger numbers of people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be a part of that continuing effort and development, and we invite your suggestions for making improvements in *Agricultural Finance Review*.

The effectiveness of this publication as a means of promoting agricultural finance research and discussion depends on its support by the profession. We have been pleased by the response in these first three years both in terms of manuscripts received and willingness of the profession to review submitted manuscripts. Twenty-three manuscripts were received for volume 45. The eleven contained herein were selected for publication. We thank all those who submitted manuscripts for our consideration.

We express our sincere thanks to the following individuals who contributed their valuable time to review submissions for us:

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Manuscripts for the 1986 issue should be received by February 1, 1986. Manuscripts will be accepted at any time, however, and those received after February 1, will be considered for the 1987 issue.

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Financial Distress on Pennsylvania Dairy Farms

William Grisley

Abstract

The financial position of a large sample of Pennsylvania dairy producers is examined for 1983 and projected to 1985. Five different debt assistance programs are investigated to determine the number of severely and moderately distressed farms that would be assisted enough to remain in business. The direct costs of these programs to lending institutions are calculated. Per farm costs ranged from \$19,589 to \$58,977 for the severely distressed group and from \$14,764 to \$39,305 for the moderately distressed group.

Key words: dairy farmers, financial stress, debt assistance programs.

The U.S. agricultural sector is undergoing a period of financial distress that will almost certainly result in an increase in the rate of farm bankruptcies and a decrease in the number of farms. As lenders to the farm sector, commercial banks, agricultural supply vendors, and others will also experience financial distress. The extent of the problem and major reasons why agriculture has become financially distressed was recently reviewed by Melichar. Eleven percent of U.S. farms in 1984 had leverage ratios between 41 and 70 percent, and eight percent had leverage ratios exceeding 70 percent. Given current prices and costs in agriculture, these highly leveraged farms are unable to meet interest obligations on their debt, let alone paying down any principal. A more recent report from Iowa State University detailed the extent of the problem in Iowa and found similar results.

Evidence suggests 20 to 30 percent of farmers nationwide currently have financial problems, and the situation could become more severe if commodity prices remain low and asset values continue to deflate (Iowa State Report). The dairy industry suffers many of the same financial problems of grain farmers, but the dairy industry's problems may be more severe in terms of finding a workable, long-term solution. Unlike grain prices, which hold some potential for upward movement given changes in world supply and demand conditions and changes in currency exchange rates, milk prices are likely to remain static or even decrease over the next few years. As a result, dairy farm incomes will decrease and high debt and inefficient farmers may be forced into bankruptcy and/or liquidation. However, allowing large numbers of high debt dairy farmers to go bankrupt may not be either

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politically feasible or economically wise. Farm debt is held by lending institutions and supply vendors, many of which are currently having financial problems. Forcing large numbers of highly leveraged farmers into bankruptcy would result in immediate losses by lending institutions and may exacerbate the downward pressure on real estate and used farm machinery and equipment prices. Supply vendors would certainly be in a less favorable position, since most of their loans are not secured by collateral.

A question of major concern is whether losses could be minimized if lending institutions were offered incentives to restructure or write down a portion of the existing debt and reschedule the remainder on terms farmers could financially handle. A limited program of this nature was announced by the USDA in the fall of 1984 and a modified version was offered in early 1985. By allocating the financial risks among lending institutions, government, and individual farmers, losses could be minimized.

Various programs have been suggested to assist qualified financially distressed farmers avoid bankruptcy (Boehlje). These include rescheduling all or part of existing debt, debt buy-out and refinancing with longer term maturity, partial or full moratorium on principal and interest for a limited number of years, debt set-aside, partial debt write-down, and interest rate reductions. Depending on the specifics of the program and eligibility requirements, farmers could remain in business and lending institutions may be able to minimize their overall losses with a minimum of government assistance. Importantly, notice would be served on farmers to get their financial house in order or face the prospect of bankruptcy. A number of highly leveraged dairy farmers are efficient milk producers and could survive the current financial crisis with a minimum of assistance. This would apply even if milk support prices are reduced further.

The purpose of this paper is twofold. First, a selected sample of Pennsylvania dairy farmers is examined to determine the most recent financial position of a large number of farmers. The financial positions are then projected to 1985. Secondly, five different alternative policies for reducing principal

and/or interest payments are evaluated on the 1985 projected financial positions to determine the number of farmers who would benefit enough to continue in business. The alternatives considered are not recommendations, but are simply used to test the extent to which they might assist financially distressed farmers.

This paper has four main sections and a conclusion. In section one the area of study, methodology, assumptions, and alternatives for relieving debt payment stress are identified. Section two contains a discussion of the current financial position of farms. Section three presents budgeted projections on financial positions for 1985. The projected costs of various debt assistance programs are discussed in section four.

Area of Study and Methodology

Farm level data are taken from the Pennsylvania Farmers Association's (PFA) annual records for 1979 and 1983. Data for 1983 are used to determine the current financial position of farms and as a baseline to make projections for 1985. For comparative purposes, the financial position of farms in 1979—a high profit year—are compared to those in 1983. These data are from dairy farms that milk 20 cows or more and receive more than 50 percent (average of 94 percent) of their gross receipts from the sale of milk. The number of farms used in the analysis was 914 in 1979 and 1,477 in 1983. Approximately 50 percent of the farms in the 1979 sample were represented in the 1983 sample. Dollar values in 1979 were adjusted to constant 1983 dollars by the implicit price deflator for personal consumption expenditures.

The 1983 PFA sample comprised about 10.5 percent of farms and 13.1 percent of milk cows in the state. Average herd size for the PFA sample was 65 cows and the state average was 53 cows. Average production per cow for the sample was 14,065 pounds and the state average was 12,939 pounds. The extent to which the PFA sample differs from the state average with respect to debt and asset levels is not known.

The criterion used to determine the financial position of a farm was the year-ending residual cash flow (RCF), defined as returns above operating expenses, interest and principal payments, and adjustments for changes in feed and supply inventories and accounts payable and receivable. This residual is the amount the farm operator has remaining to pay family living expenses and income taxes, depreciation replacement, and additions to the capital stock. Even though RCF is not all cash, current assets in inventory are highly liquid and can be converted into cash. Off-farm income was not considered in the analysis because data were unavailable. The omission of off-farm income in an investigation of farm business financial position can result in an overstatement of the problem. As recently noted by Melichar, off-farm income is sizable for smaller farms. However, dairy production involves daily labor operations and management. Farmers with 30 cows or more are full-time operators and most have little time for off-farm employment.

Farms were categorized into three groups by RCF: (a) severely distressed; (b) moderately distressed; and (c) financially sound. The severely distressed group included farms with a zero or negative RCF. Without infusions of outside funds, refinancing, or restructuring of debt, these farms will not be able to continue in production. The moderately distressed group includes farms that have RCFs falling in the range of \$1 to \$15,000. These farms can meet all expenses and pay part of the family living expense. Farms in the financially sound group have RCFs exceeding \$15,000. These farms have sufficient income to pay all farm and family living expenses and in certain cases, make new investments for growth.

Actual results in 1983 were adjusted at the farm level to arrive at projected RCFs for 1985. A budgeting technique was used to arrive at the 1985 projections. Assumptions were made on changes in operating expenses, milk production per cow, milk prices, and crop yields. Herd size and crop acres were assumed to remain static at 1983 levels. All operating expenses except interest were assumed to increase at an annual rate of 1.5 percent, equal to the increase in the prices-paid index by farmers from 1983 to October 1984 (*Agricultural Outlook*,

November 1984). Average operating expenses were \$89,448 per farm in 1983. Milk production per cow was assumed to increase at 1.5 percent per year, equal to the annual average rate of increase of farms in the PFA record keeping service from 1979 to 1983 (*Pennsylvania Dairy Farm Business Analysis*, 1979 to 1983). Two assumptions were made on milk prices. First, prices were reduced 50 cents, and secondly, \$1 per hundredweight less than the farm gate price received in 1983. The average price received for all milk at the farm level in the 1983 PFA sample was \$12.75 per hundredweight.

Since 1983 was a drought year, resulting in lower than average crop yields, yields in the 1985 projections were adjusted to 1982 levels—a year considered to be average for crop production, with corn yields at 96 bushels per acre, corn silage at 15.5 tons per acre, and hay equivalent at 3.3 tons per acre. Using 1982 and 1983 PFA records, crop yields were adjusted by herd-size group. 1985 harvest period futures market prices for grains, and an assigned price of \$28.50 per ton for corn silage and \$75 per ton for hay were used in the calculation.

The RCF projections for 1985 with milk prices 50 cents less per hundredweight were used as the basis from which to evaluate financial distress under different debt assistance alternatives. Five policies that affect the level of debt and annual principal and/or interest payments were considered. Policy A was a moratorium on all principal payments for a period of five years. Interest payments on all debt would continue over the five-year period at 1983 levels. Policies B and C were refinancing programs of all debt. Under B, debt was refinanced at a 14 percent interest rate over a period of 25 years, assuming an annual amortized repayment schedule. The interest rate used approximates the rate charged by the Federal Land Bank for long-term loans in 1983 and 1984. To evaluate the effect of a subsidized rate, the interest rate under Policy C was decreased to seven percent for the first five years of the 25-year period. Policy D was a 25 percent set-aside on all principal and interest for a period of five years. Payments for the remaining 75 percent would continue as scheduled in 1983. Policy E was an immediate 10 percent write-off of all debt. Principal and interest payments on the

remaining 90 percent of debt would continue as before the write-off. Policies D and E are similar to the announced program of USDA in the fall of 1984.

The effect of policy alternatives on projected cash flow was evaluated for a single year only. No guidelines were established as to which farmers would be eligible. The purpose of the analysis is to show the number of farmers that would be assisted enough to move from the severely to the moderately distressed category and to move from the moderately distressed to the financially sound category.

Current Financial Position

Total debt per farm is reported in table 1 by herd size and debt-to-asset ratio groups and for all farms in 1983. One-hundred and forty-three, or 9.7 percent, of the 1,477 farms studied were debt free. Fifty-eight percent of these farms had less than 60 cows. Debt as a percent of assets averaged 34 percent from farms with debt and 31 percent across all farms. By comparison, these percentages were 24 and 22 percent, respectively, in 1979. Average debt per farm was \$153,400 and average debt per cow was \$2,417 for farms with debt. For all farms these values were \$138,548 and \$2,183, respectively. Farms with

debt in the largest herd size group has the highest debt per cow at \$2,563, and the smallest group had the lowest at \$2,190. Across all farms with debt, an average of 56 percent of the debt had maturity exceeding 10 years. Smaller farms, and farms with lower debt-to-asset ratio had a smaller percentage of long-term debt. The 218 farms, or 16 percent, with debt-to-asset ratios of 0.60 or greater had 32 percent of the total debt. Average debt for these farms was \$300,882.

The average rate of return on equity, defined as net farm income before family withdrawals or a charge on equity investment and divided by year ending market value of equity, was 2.4 percent for all farms (table 1). By comparison, the average rate of return on equity was 6.7 percent in 1979. Average rate of return on equity was positive for farms with less than 45 percent debt and negative at higher debt levels. In general, this pattern was consistent across farms with different herd sizes. These results indicate that high debt farms were not receiving a positive return on equity invested. Even without deflation in the market value of assets, these farms were using up their equity. If continued over a period of time, total farm borrowing capacity would decrease, making refinancing and gaining access to additional credit more difficult.

Table 1. Number of Farms and Total Debt Per Farm by Debt-to-Asset and Herd-Size Groups and Rate of Return on Equity by Debt-to-Asset Groups, Pennsylvania Dairy Farms, 1981.

Debt as % of assets	Herd size in cows per farm												
	20 to 39 ^a (333)		40 to 59 (529)		60 to 79 (309)		80 to 99 (132)		100 or more (174)		All farms (1,477)		
	No. farms	\$1,000 of debt	No. farms	\$1,000 of debt	No. farms	\$1,000 of debt	No. farms	\$1,000 of debt	No. farms	\$1,000 of debt	No. farms	\$1,000 of debt	% return ^b on equity
0	48	0.0	54	0.0	27	0.0	6	0.0	8	0.0	143	0.0	4.7
1 to 14	112	21.9	136	34.3	94	43.7	28	41.5	33	86.4	403	37.3	3.3
15 to 29	66	58.2	115	83.3	60	121.3	30	169.4	36	230.4	307	111.0	2.5
31 to 44	52	190.3	80	152.1	54	197.7	26	249.6	37	377.9	249	194.9	1.4
45 to 59	17	131.5	58	190.7	34	263.1	21	314.6	27	464.5	157	263.6	-0.04
60 to 79	24	152.3	55	223.5	24	260.5	12	381.5	19	486.8	134	268.9	-4.1
80 or more	14	185.8	31	260.4	16	370.7	9	407.1	14	663.9	84	351.9	-14.1
All Farms with debt	285	70.2	475	121.8	282	152.5	126	218.9	166	338.6	1,334	153.4	2.4 ^c

^aHerd-size group: number of farms per group in parentheses, number of farms by debt-to-asset and herd size groups, and \$1,000 of debt is thousands of dollars of total debt per farm.

^bNet farm income divided by total equity investment.

^cAverage for all farms.

Residual cash flows for 1979 and 1983 are summarized by debt-to-asset ratio groups in table 2. For each group, farms were classified as either severely, moderately, or not financially distressed. A comparison of RCFs between 1979 and 1983 shows the extent to which financial problems have increased. Seventy-eight, or nine percent, of the 914 farms studied in 1979 had RCFs that were zero or negative and 119, or 13 percent, had RCFs between \$1 and \$15,000. Even in the best of years a significant proportion of farms were having financial problems. By comparison, 360, or 24 percent, of the farms in 1983 had a zero or negative RCF and 364, or 25 percent, had an RCF between \$1 and \$15,000. For all farms, average RCF was

\$38,200 in 1979 and \$14,800 in 1983, a 61 percent decrease over the four-year period.

Higher leveraging increased the percentage of farms with severe cash flow problems in both years. The problem was more pronounced in 1983 as 20 percent or more of the farms in each debt-to-asset ratio group exceeding 14 percent debt had severe financial problems. Forty-nine percent of the farms in the 60 to 79 debt-to-asset group and 41 percent in the 80 and over debt-to-asset group have a zero or negative RCF. In 1979, only the group with 80 or more percent of debt had a high percentage of farms in the severely distressed category. Notably, a significant number of farms in the high debt

Table 2. Average Residual Cash Flow by Debt-to-Asset Ratio, Actual 1979 and 1983 and Projected 1985 Before Debt Assistance Options, Pennsylvania Dairy Farms.

Debt as % of assets	Actual, 1979		Actual, 1983		Projected, 1985 (Milk, \$0.50 Less/Cwt)		Projected, 1985 (Milk, \$1 Less/Cwt)	
	No. farms	\$1,000 ^a residual cash flow	No. farms	\$1,000 residual cash flow	No. farms	\$1,000 residual cash flow	No. farms	\$1,000 residual ^a cash flow
0	1 ^b	-2.0	3	-3.2	1	-6.0	3	-3.5
	7 ^c	9.3	19	9.5	15	8.8	17	9.3
	75 ^d	60.6	122	42.3	127	47.5	123	44.4
1 to 14	7	-13.7	41	-13.0	24	-14.5	30	-14.2
	18	9.9	96	8.3	72	8.9	90	8.6
	199	53.1	266	40.0	307	45.9	283	43.7
15 to 29	17	-26.6	61	-18.4	35	-19.2	43	-18.3
	24	8.6	90	8.5	62	8.6	80	8.8
	175	52.0	156	33.7	210	38.8	184	36.9
30 to 44	16	-24.5	100	-25.2	75	-21.8	90	-21.7
	15	9.7	55	7.6	51	7.4	54	7.8
	137	48.0	94	39.2	123	44.5	105	43.3
45 to 59	17	-40.4	55	-38.4	44	-37.2	51	-36.6
	32	7.9	46	6.3	38	7.7	38	6.6
	80	43.7	56	32.7	75	40.6	68	37.1
60 to 79	13	-54.1	66	-31.3	50	-31.2	59	-30.3
	15	8.7	40	7.4	38	8.4	38	8.0
	43	44.0	28	33.5	46	33.6	37	32.5
80 or more	7	-47.1	34	-40.2	25	-45.4	30	-41.4
	8	6.4	18	8.1	22	8.2	18	6.4
	8	44.6	32	36.4	37	44.0	36	39.4
All farms	78	-34.1	360	-27.0	254	-27.0	306	-26.4
	119	8.6	364	7.9	298	8.3	335	8.1
	717	50.9	753	38.0	925	43.2	836	41.1
Summary	914	38.2	1,477	14.8	1,477	24.0	1,477	19.6

^aThe residual cash flow for 1979 was adjusted to 1983 constant dollars by the implicit price deflator.

^bNumber of farms with a zero or negative residual cash flow.

^cNumber of farms with a residual cash flow between \$1 and \$15,000.

^dNumber of farms with a residual cash flow greater than \$15,000.

groups had RCFs exceeding \$15,000. These farms may have been more efficient than their counterparts with zero or negative RCFs, but could also have had more favorable financing terms. Since farmers' estimates of the market value of real estate and intermediate assets were used in measuring asset values, some of the farms falling in the high debt groups may have occurred because of an undervaluing of assets.

In summary, a higher percentage of farms in 1983 had severe financial problems than in 1979. Severe financial problems occurred at lower debt-to-asset ratios in 1983 as compared to 1979. While 1979 was considered to be a good year for dairy producers, these results do indicate increasing numbers of farmers were having financial problems by 1983. The results also indicate 51 percent of farms in 1983 were realizing large cash flows, an average of \$38,000 per farm. This group in 1979 comprised 78 percent of the farms and averaged \$50,900 in RCF.

Projections for 1985

Projected RCFs were budgeted at the farm level for 1985 using the assumptions outlined in section one. For comparative purposes, RCF was budgeted first with milk prices at 50 cents, and secondly, at \$1 per hundredweight less than actual farm-gate prices received in 1983. Two-hundred and fifty-four, or 17 percent, of the farms had a zero or negative RCF, and 298, or 20 percent, had an RCF between \$1 and \$15,000 when milk was decreased by 50 cents per hundredweight (table 2). The number of farms with severe cash flow problems decreased from the actual in 1983 because higher yields on grain and corn silage were assumed in the 1985 projections. At milk prices \$1 per hundredweight less, 306, or 21 percent, of the farms were projected to have severe financial problems, and 335, or 23 percent, were projected to have moderate financial problems. These percentages are only slightly less than the actual percentages for 1983. By decreasing the price of milk from 50 cents to \$1 per hundredweight less, an increase in 52 farms had zero or negative RCFs.

These results show a significant number of farms could have severe financial problems by 1985, even if 1985 crop yields reach the

1982 average. Preliminary evidence from PFA field personnel suggests farmers have been able to pay-down some debt in 1983. If debt loads have been decreasing, the percentage of farms that will have severe financial problems could be less than projected here. However, farmers with the most severe cash flow problems are least able to pay off debt unless outside funds are available.

It is not known how the financial position of the 1,477 farms studied compares to all farms in the state. As noted above, the sample studied had a larger average herd size and produced higher levels of milk per cow. The difference in production suggest farms in general are worse off than those sampled, assuming a similar distribution of debt-to-assets. For lack of a better measure on the number of farms statewide that could have financial problems by 1985, the above results projected for 1985 are extrapolated to the state level. Extrapolating the percentage of farms projected to have severe and moderate financial problems at a milk price of 50 cents per hundredweight less than 1983 prices, gives a total of 2,520 farms in the severely distressed category and 3,080 in the moderately distressed category. With milk prices at \$1 per hundredweight less, 3,200 farms fall in the severely distressed category and 3,360 in the moderately distressed category. While these figures are extrapolations from projected numbers, they may indicate that a large number of dairy farmers could have financial problems by 1985.

Effects of Policy Alternatives

Five policy alternatives designed to assist financially distressed farms were evaluated. No criteria were established to determine which farmers could be eligible for assistance. The source of debt financing was not known, and all farms were therefore assumed to borrow from a common lender. In practice, a debt servicing assistance program would be specific to the type of lending institution, depending on whether it is private, public, or a farmer-owned cooperative. Farms with moderate and no financial problems were included in the tabulation to show how many farms would change financial position categories. In application, farms with higher cash flows in the former group and all farms in the latter

group may not be eligible for, nor require financial assistance. To reiterate, Policy A is a moratorium on all principal payments for five years, Policy B is refinancing of all debt at 14 percent interest for 25 years, Policy C is identical to B except the interest rate is seven percent for the first five years of the loan length, Policy D is a 25 percent reduction on principal and accrued interest for a five-year period, and Policy E is a 10 percent permanent write-off on outstanding debt. Under Policies A, C, and D, principal and/or interest payments would increase after a period of five years, but this effect would not be observed in 1985.

Effects of the policy alternatives on RCF are reported in table 3. Under Policy A, 54 of the 254 severely distressed farms remained in that category. One-hundred and fifty-one farms moved from the severely distressed to moderately distressed category and 49 moved from the severely distressed to financially sound category. Two-hundred and ninety-eight farms in the moderately distressed

category moved to the financially sound category. A moratorium on principal payments would clearly help a considerable number of farmers and could, if the moratorium was long enough, enable many financially distressed farms to work out of their financial crises.

Under Policy B, 177 of the 254 financially distressed farms remained in that category. Only 77 percent of the 254 farms projected to be severely distressed in 1985 would be significantly assisted enough under a debt refinancing program with an interest rate at 14 percent over a 25-year period to move to the moderately distressed category. Reducing the interest rate to seven percent in refinancing Policy C, left only six percent or 86 farms in the severely distressed category. Sixty-six percent, or 168, of the 254 severely distressed farms would move to the moderately distressed category. Two-hundred and fifty-three farms would move from the moderately distressed to the financially sound category.

Table 3. Summary of Financial Position of Farms Under Debt Assistance Policy Alternatives, Projected 1985, Pennsylvania Dairy Farms

Policy alternative	No. farms	Percent farms	\$1,000 residual cash flow after debt assistance, 1985
Projected 1985 ^a	254 ^b	17	-27.0
	298 ^c	20	8.3
	925 ^d	73	43.2
A. Moratorium on principal payments for 5 yrs.	54	4	-16.8
	157	10	9.7
	1,272	86	56.8
B. Refinancing at 14% and 25 yrs.	177	12	-17.8
	293	20	8.5
	1,007	68	45.7
C. Refinancing at 7% and 25 yrs.	86	6	-16.5
	218	14	8.7
	1,178	80	48.6
D. 25% reduction on principal and interest for 5 yrs.	101	7	-28.4
	202	14	8.7
	1,174	79	54.1
E. 10% write-off on principal	134	9	-29.8
	213	14	7.8
	1,130	77	52.0

^aThe projected results for 1985 without any assistance are included for comparative purposes (see table 2, Actual 1983, all farms).

^bNumber of farms with a zero or negative residual cash flow.

^cNumber of farms with a residual cash flow between \$1 and \$15,000.

^dNumber of farms with a residual cash flow greater than \$15,000.

Under Policies D and E, seven and nine percent, respectively, of the severely distressed farms would remain in that category. The 25 percent reduction in principal and interest payments under Policy D would enable 153 farms to move from the severely to moderately distressed category. Two-hundred and forty-nine would move from the moderately distressed to the financially sound category. Under Policy E, 120 farms would move from severely distressed to moderately distressed category, and 205 would move from the moderately distressed to financially sound category. The variation in projected financial positions of farms under policies D and E approximate the variation in the actual financial position of farms in 1979.

Projected Costs of Policy Alternatives

A question of considerable interest is the cost to lending institutions of the various debt assistance policy alternatives considered. Since actual interest rates, remaining length of loans to maturity, and repayment schedules were not known with certainty, an approximation was used in calculating the costs. Under those policy alternatives that would have costs over each of the five years (Policies A, C, D, and E), the present value of the costs was calculated using a discount rate of 10 percent. No administrative or other secondary costs were considered in the calculations.

Under Policy A (a moratorium on all principal payments for five years) the interest revenue foregone by the lender over the five years on these payments was calculated using an interest rate of 14 percent. The cost of Policy B was not calculated because it was a refinancing program of total indebtedness at 14 percent interest for 25 years. However, lending institutions would almost certainly face higher risks in refinancing since much of the debt would not be secured by collateral. If government insured the refinancing program at some percentage of total indebtedness, risks to the lending institutions would decrease, but risks to the government could be substantial. The cost of Policy C would be the subsidized interest rate of seven percent on all debt for five years. Under Policy D, the cost would be

the revenue foregone by the lender on 25 percent of the principal and interest for a period of five years. The cost of Policy E would be an immediate loss of 10 percent of the outstanding principal. The cost of the government guarantee on some percentage of the remaining debt was not considered in the calculation, even though it could be substantial if a large number of farmers are forced into bankruptcy in later years.

In calculating the direct cost of the alternative policies, only those farms in the severely distressed category and those in the moderately distressed category with RCFs of \$5,000 or less that would be assisted by the policies were considered. That is, only the financially distressed farms that could be assisted enough to move out of that category and the moderately distressed farms with \$5,000 or less RCF that would be assisted enough to move out of that category were considered. It is unlikely that farms in the severely distressed category who could not show a positive RCF with assistance would be eligible. Farms with RCFs exceeding \$5,000 may also not be eligible and were not considered.

The number of farms assisted, average program cost per farm, and average farm net worth for the sample studied are shown in the upper part of table 4. These costs were extrapolated to farms on a statewide basis in the lower part of the table. Program costs for sample farms that would be assisted enough to move from the severely distressed group ranged from \$19,587 to \$58,977 per farm. The 10 percent write-off on the principal, Policy E, had the lowest cost per farm, but assisted the fewest number of farms. Average net worth of the 120 severely distressed farms assisted under Policy E was \$235,000 in 1983. The costs for the moderately distressed group with 1985 projected RCFs of less than \$5,000 ranged from \$12,465 to \$39,305. Subsidizing the interest rate for five years at seven percent was the most costly program. The farms assisted in the moderately distressed group under all policy alternatives had a smaller average net worth than farms in the severely distressed group. When summed across all farms assisted, even the least costly program would involve significant direct losses for lending institutions.

Table 4. Number of Farms Benefiting From and Direct Cost of Debt Assistance Policy Alternatives, Pennsylvania Dairy Farms

Policy alternative	Severely distressed 1985 ^a			Moderately distressed 1985 ^b		
	No. farms	Debt assistance cost per farm	Equity per farm \$1,000	No. farms	Debt assistance cost per farm	Equity per farm \$1,000
1,477 sample farms						
A. Moratorium on principal payments for 5 years	200	\$24,989 ^c	\$151	111	\$12,465 ^c	\$167
C. Refinancing at 7% and 25 years	177	58,977 ^c	249	129	39,305 ^c	191
D. 25% reduction on principal and interest for 5 years	153	38,065 ^c	237	158	27,278 ^c	192
E. 10% write-off on principal	120	19,589	235	156	14,764	202
14,000 Pennsylvania farms ^d						
A. Moratorium on principal payments for 5 years	1,896	20,366 ^c		1,052	10,159 ^c	
C. Refinancing at 7% and 25 years	1,678	48,066 ^c		1,223	32,033 ^c	
D. 25% reduction on principal and interest for 5 years	1,450	21,623 ^c		1,498	22,223 ^c	
E. 10% write-off on principal	1,137	15,965		1,479	12,033	

^aFarms in the projected severely distressed category that would be able to realize positive residual cash flows.

^bFarms in the moderately distressed category with projected cash flows of \$1 to \$5,000 in 1985 that may be eligible for assistance.

^cThese debt assistance programs would have costs over a five-year period. The costs reported have been discounted using a discount rate of 10 percent.

^dExtrapolating to statewide basis assuming average farm is 81.5 percent as large as the average farm in the sample studied.

Extrapolating these results to the 14,000 dairy farms in the state shows that considerable sums of money would be involved. Per farm costs at the state level would be less than those in the sample because farm size is smaller. Summing across farms that may be eligible for assistance shows all debt assistance programs to be costly.

Summary and Conclusions

The current oversupply problem in the dairy industry serves as a strong economic argument to reduce milk support prices. In late 1983 and early 1984 milk prices were reduced and further reductions could occur in early 1985. These reductions come at a time when large numbers of dairy farmers are having financial problems, primarily as a result of high levels of indebtedness. Many high-debt farms could be forced into bankruptcy and/or liquidation. This situation could accelerate the downward pressure on real estate and machinery and equipment prices and result in low rates of debt recovery from liquidated farms and a forced write-down of secured collateral on

remaining farms with debt. If incentives were offered to restructure or refinance outstanding debt, lending institutions could minimize their losses, and the more efficient dairy farms with high levels of indebtedness may be able to work their way out of the current financial crises.

In 1983, 24 percent of the 1,477 dairy farms in the Pennsylvania Farmers Association's record keeping service had residual cash flows that were zero or negative and 25 percent had positive cash flows of less than \$15,000. The former group could not pay all interest and principal payments and had no income remaining for family living expenses. Without infusions of outside funds or rescheduling or refinancing of existing debt, these farms will not be able to continue in business. By comparison, 9 percent of farms in 1979 were severely distressed and 13 percent were moderately distressed. The projected financial position of farms in 1985 was not as serious as in 1983 in terms of the number of farms in the severely distressed category, assuming crop yields in 1985 were at normal levels. Seventeen percent, or 254, of the 1,477 farms would still

have zero or negative residual cash flow and 20 percent would have positive cash flows of less than \$15,000.

Reducing principal and/or interest payments would enable a number of farmers to work out of their current financial crises, but at high costs to lending institutions and governmental agencies. A five-year moratorium on all principal payments would assist 201 of the severely distressed and 298 of the moderately distressed farmers. Direct average costs per farm to lending institutions for these two groups were estimated at \$24,989 and \$12,465, respectively, when discounted over the five-year period. The two announced USDA programs—a 25 percent reduction on principal and interest payments for five years for Farmers Home Administration borrowers and a 10 percent write-off on outstanding principal for commercial bank and farm credit system borrowers—would assist a substantial number of farmers. Direct discounted costs per farm for the former program were estimated at \$38,065 for the severely distressed group and \$27,278 for the moderately distressed group over the five-year period. The latter program would be less expensive with direct costs per farm of \$19,584 for the severely distressed group and \$14,764 for the moderately distressed group. When summed over all dairy farms in the state that might be eligible for assistance, total program costs to lending institutions could be large. A debt refinancing program at 14 percent over 25 years would have no direct costs, but indirect costs in the form of higher risks to the lender could be substantial.

What are the merits of emergency programs that financially assist farmers? An important negative aspect is that a precedent will be established, resulting in farmers expecting further assistance in the future. Positive aspects include assisting efficient, but highly indebted farmers and enabling lending institutions to recover part of the financial problem loans outstanding. Benefits to lending institutions could be large if the program was offered to those farmers who could show future financial feasibility under limited principal and/or interest payment reductions.

It is widely believed that smaller dairy farmers in Pennsylvania use substantial amounts of off-farm income to subsidize the farm operation. The importance of off-farm income was not considered in this analysis because information was unavailable. In a recent nonrandom sample of 293 dairy farms, 20 percent were found to hold off-farm employment. The amount of off-farm income earned was not known. However, it would be expected this income was being used for family living expenses and debt servicing. If off-farm employment is prevalent, the overall financial position of the severely and moderately distressed farms may not be as serious as that shown in this study. Further research is needed to determine the importance of off-farm income in keeping dairy farms financially liquid.

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Income Tax Simplification Effects on Crop Farm Decision Making

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Abstract

The impact of the U.S. Treasury Department's 1984 proposed income tax simplification provisions on crop farm decision making is examined using a dynamic nonlinear optimization model. The model incorporates the integrated nature of the firm's production, investment, and financing decisions, and controls income tax liabilities as part of the overall optimization problem. The results indicate that extending depreciation periods, eliminating the investment tax credit, and consolidating tax brackets will result in lower total taxes, increased net worth, increased farm investment in land, and decreased investment in machinery.

Key words: farm investment, farm taxes, dynamic optimization.

Changing income tax provisions can have significant long-run impacts on farm firm investment and operating decisions and can be an important determinant of the structure of agriculture. Recently introduced proposals for income tax simplification have raised questions of comparative impacts by industry and economic sector. Analysts have determined that each of the three major tax simplification proposals would reduce the total tax bill of individual taxpayers while increasing the corporate sector's total tax burden. No analysis has been made of the effect of tax simplification proposals on the farm sector.

Previous studies of tax laws and tax law changes (Dean and Carter; Vandeputte and Baker; Lin, Carman, Moore, and Dean; Egington; Reid, Musser, and Martin, 1978 and 1980; Penson, Romain, and Hughes; Carman, 1972 and 1981; Nixon and Richardson; Davenport, Boehlje, and Martin; Richardson, Nixon, and Smith; and Hanson), have demonstrated that the major provisions included in tax simplification can be expected to have long-term impacts on the agricultural sector. The objective of this paper is to analyze the impact of three of the major proposed changes—the collapsed tax rate structure, elimination of the investment tax credit, and the extended depreciation schedules—on crop farm decisions related to land and machinery purchases, land leasing, crop production, and debt. The representative farm approach is used to determine the long-term effects of the revisions on individual farm operators.

Tax Simplification Proposals

The need to simplify the Federal Income Tax Code is gaining widespread acceptance and numerous simplification proposals have been

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advanced. Three proposals that have received serious consideration are the Gephardt-Bradley and Kemp-Kasten bills and the Treasury Department's 1984 proposal. All three proposals provide changes in standard deductions, personal exemptions, and reduce the number of tax brackets to a maximum of three. Following is a brief discussion of the major provisions in each proposal.

The Gephardt-Bradley bill establishes three tax brackets for individual income, beginning at 14 percent. A 12 percent surtax is applied to income above \$25,000 for a single taxpayer (\$40,000 for a joint return) and an additional 16 percent surtax is placed on income above \$37,500 for a single taxpayer (\$65,000 for a joint return). The surtaxes apply to gross income, rather than taxable income after deductions. The bill also eliminates the investment tax credit, indexing, and deductions for state and local income taxes, sales taxes, and personal property taxes. It raises the maximum capital gains tax rate from today's 20 percent to 30 percent and extends depreciation schedules similar to those in effect prior to Accelerated Cost Recovery System (ACRS). Heavy farm machinery is depreciated over 10 years with depreciation equal to 25 percent of the declining balance. The Gephardt-Bradley bill lowers the top tax rate on corporate income to 30 percent.

The Kemp-Kasten legislation also eliminates deductions for state and local income taxes and the investment tax credit. It lowers corporate tax rates to a maximum of 30 percent, but it also creates a special rate of 15 percent for companies making less than \$50,000 a year. It eliminates the current 16 income brackets with a flat 25 percent tax rate on income, with a partial exclusion on income subject to the Social Security tax. The exclusion is phased out as income rises. The Kemp-Kasten bill retains ACRS. It raises the top tax rate on capital gains to 25 percent but indexes the gains against inflation.

The Treasury Department's 1984 proposal resembles the Gephardt-Bradley bill. It consolidates the tax brackets into three levels. For joint returns, income not exceeding \$31,800 is taxed at 15 percent, income between \$31,800 and \$63,800 is

taxed at 25 percent and income in excess of \$63,800 is taxed at 35 percent; the brackets are indexed to inflation. It also indexes interest deductions and earnings to inflation. The proposal reduces the top corporate tax rate to 33 percent from 46 percent but it also lengthens depreciation schedules compared to ACRS. Heavy farm machinery is depreciated over 12 years with depreciation equal to 18 percent of the declining balance, but indexed to inflation. It repeals the special treatment of capital gains but adjusts the gains for inflation.

Analytical Model

This study applies a dynamic optimization model to evaluate the impact of tax simplification provisions on farm firms. The use of an optimization model, which is unique for the analysis of agricultural investment response to changing income tax laws, avoids the problems evident in most simulation studies (Eginton; Nixon and Richardson; Richardson, Nixon and Smith). Simulation studies are typically forced to rely on rather rigid rules of thumb to determine agricultural investment patterns, even though it has been demonstrated that optimal investment is altered by changes in tax rules (Jorgenson, 1963 and 1967).

The dynamic optimization model used in this study incorporates the integrated nature of the firm's production, investment, and financing decisions. Given a particular set of tax rules, the firm controls the levels of its income tax liabilities as part of its overall optimization problem. All decisions for all time periods are solved simultaneously.

The intertemporal effects of the firm's decisions are evaluated using optimal control theory. The firm's decisions affect the levels of its stocks, which flow between time periods. Investment in the current period influences both production capacity and tax liabilities in the present and the future. Thus, changes in tax rules have an intertemporal impact on the farm firm; current optimal production, investment, and financing decisions are dependent upon such decisions in the past, as well as upon expectations of future production, investment, and financing opportunities.

The model is deterministic.¹ The firm has an uncertain distant termination date. Its objective criterion is maximization of its net present value. Given a finite time horizon, this is equivalent to maximizing the present value of the firm's net worth in the terminal period where net worth is measured by its assets less its liabilities. As determined by Reid, Musser, and Martin (1978), implicit taxation of a nonliquidating firm's assets in the final period is not required.

Decisions are made in a discrete time frame. For each period, the firm must make decisions concerning crop mix, machinery utilization, land leasing, land purchases and sales, machinery purchases and sales, and refinancing.

Machinery is a major cost component for a typical crop farm. In previous studies, the effect of tax rules on machinery replacement decisions has been evaluated as a separate problem with no consideration of the firm's ability to invest (Smith; Chisholm; Kay and Rister; Bates, Rayner and Custance; and Reid and Bradford). The machinery replacement problem is built-in to the overall optimization problem in this study. The effects of machinery use on machine downtime and repair costs are incorporated in the model.

The model is divided into three principal sectors: the production sector, the tax depreciation sector, and the financial sector. There are flows between sectors and a decision can affect more than one sector.

Crop production occurs in the production sector subject to a specified production technology and production capacity constraints. There are two kinds of stock in the production sector: land and machinery.² The land production stock is measured in acres. It is affected by land purchases, sales, and leasing. The machinery production stock

represents the number of machinery hours available to perform a particular crop production activity. It is affected by machinery purchases, sales, and use. All such decisions must be distinguished by the vintage of the machine.

The firm's current and previous investment decisions affect its income tax liabilities. The tax depreciation stock measures the remaining amount of depreciation available on the machinery owned by the firm. A portion of this stock flows, according to tax depreciation rules, to provide depreciation deductions from the firm's taxable income. Machinery purchases and sales affect the level of this stock.

The firm has three kinds of financial stock: the market values of its physical assets (land and machinery); debt; and savings. These stocks determine the firm's net worth. The debt stock is affected by decisions concerning land purchases and sales, machinery purchases and sales, and refinancing. Borrowing is restricted by equity requirements. The firm's savings account represents a nonfarm investment opportunity. The change in the savings stock is determined by the net cash flow in each period—net crop revenues plus revenues from land and machinery sales and funds from refinancing, less loan amortization payments, down payments for asset purchases, machinery repair costs, loan payoffs, and tax liabilities.

Model Constraints and Assumptions

The dynamic optimization model is applied to a representative row crop farm located in Yolo County, California, to analyze the long-term effects of income tax simplification provisions. The area has a level topography which facilitates extensive irrigated cultivation of row and orchard crops. The firm's planning period is 1981 through 1988. The objective function value is the present value of the firm's land, machinery, and savings less its debt balances from land and machinery purchases and refinancings.

The discount rates used in the model represent the nominal, after-tax rate of return obtainable on an alternative agricultural investment. The annual discount rates are: 1981, .021; 1982, 0.0; 1983, .063; 1984, .015;

¹In a previous study analyzing the impact of the 1981 Tax Act, Hardesty incorporated stochastic crop revenues into a dynamic optimization model using an iterative approach. The results did not differ substantially from those of the deterministic formulation of the problem.

²Buildings are omitted from the model because of difficulties in determining building requirements and changes in building capacity. Relative to land and machinery, the role of buildings in row crop production is minor.

and 1985 through 1988, .07. The rates originate from Melichar's findings (1984) and include capital gains from land. The values for 1985 through 1988 are based on the assumption that the annual inflation rate for this period will be five percent and that the agricultural economy will begin to recover. The recovery will be limited, such that real annual returns to agriculture will rise to two percent, lower than the four percent long-term rate determined by Melichar.

The representative farm owns 640 acres; half of the acreage was purchased in 1961 for \$800 an acre and financed with a 5.64 percent fixed rate loan and the remainder in 1971 for \$1,000 an acre and financed with a 7.86 percent fixed rate loan. This farm size is less than the 933-acre average size in 1982 for farms in the county with sales of \$10,000 or more (1982 Census of Agriculture). The farm owns two large crawler tractors, a medium-size combine, and an electronic-eye tomato harvester. All of these machines were purchased in 1976 and financed with a 8.24 percent fixed rate loan. These machine types represent the most costly part of the typical machinery complement for a 640-acre farm in the county (Carter and Johnston). Other machine types are not identified separately because of size constraints on the nonlinear programming problem. The farm has \$19,000 in savings, based on the average holdings of financial assets of California farm operators in 1979 (1979 Farm Finance Survey), which were inflated accordingly. At the beginning of the planning problem, the firm's assets are valued at \$2,924,667 and its debt to asset ratio is .12, which is representative of established farms in the county.

Cropping alternatives include the major row crops grown in the county—processing tomatoes, field corn, sugar beets, and winter wheat. Institutional marketing practices prohibit the farm from varying its tomato acreage by more than 15 percent in any given year. The farm can lease land on a share-rent basis. Total growth in acreage is limited to 80 acres a year due to the restricted availability of suitable land for expansion.

Five different machine activities are specified in the model. The firm's capacity with respect to these activities depends on the optimal period for performing these activities.

The capacity also reflects weather induced delays and machinery downtime; the estimation of the downtime functions is described in Hardesty. The firm has a Leontief production technology. The machinery requirements associated with these activities are based on enterprise budgets (University of California, Cooperative Extension). Machinery requirement constraints specify that the number of machines of a specific type and vintage multiplied by the number of hours the machine is used for an activity, summed over all vintages, equals the machinery requirement per acre multiplied by the number of acres planted of each crop. There are 40 of these nonlinear constraints in the programming model.

Based on actual data, land prices for 1981 through 1983 are \$4,300, \$4,400, and \$4,500 an acre, respectively. In 1984, the price of land dropped sharply to \$3,800. It is assumed that the farm income situation begins recovering in 1985. As a result of improved income expectations, land prices rise to match the annual inflation rate of five percent.

The interest rates are based on actual rates for 1981 through 1984. The interest rates on land, operating, and machinery loans from 1985 through 1988 are, respectively: 13, 12.25, 11.5, and 11 percent. The same rates are applicable to refinancings. The interest rate on land loans is variable; it is fixed on machinery loans. Land loans and refinancing are amortized over 30 years and machinery loans have a five-year amortization period. A 25 percent down payment is required on all asset purchases.

Actual machinery prices are used in the model for 1981 through 1984. Between 1985 and 1988, they increase by five percent annually. Used machinery is valued according to the resale price relationships published in the *Agricultural Engineer's Yearbook*.

Revenue from crop production is a function of crop acreages, prices, and yields. Prices and yields are deterministic in the model. Actual county average prices and yields are used for 1981 through 1984. Yields for 1985 through 1988 are held constant at the 1979 through 1983 five-year averages. Output

prices for 1985 through 1988 are equal to the 1979-1983 average of real prices (deflated using the Index of Prices Paid by Producers) and applying a five percent inflation rate during the projection period. The firm is assumed to finance and repay 100 percent of its variable operating costs. Operating deficits are covered by withdrawals from savings, sales of assets, and/or financing. Machinery repair costs reduce the firm's cash flow; they are a function of cumulative machine hours as described in Hardesty. Calculating total repair costs requires nonlinear constraints, which contain the product of the number of machines and the cumulative hours on the machines, summed across all vintages.

There is no off-farm income. There are four members in the farm household. Household consumption expenditures remain constant, in real terms, at \$19,800 in 1981 dollars, based on USDA's 1973 Farm Operator Family Living Expenditure Survey. This assumption is consistent with the permanent income hypothesis. Consumption withdrawals reduce the farm firm's savings.

Local property taxes, the self-employment tax, and federal and state income taxes are other costs which reduce the firm's net cash flow. The farm firm is assumed to file its income tax returns as a married couple, filing jointly. It claims four exemptions and uses the standard deduction. Deductible expenses include variable operating costs, lease payments, machinery repair costs, interest payments, property taxes, state income taxes, and depreciation; the depreciation is subject to recapture when an asset is sold. There are investment tax credits generated by machinery purchases; these credits are subject to recapture provisions.

There are capital losses associated with the sale of some relatively new machinery. The tax rules require that the net gain or loss from the sale of all such Section 1231 property must be determined; a net gain is treated as a capital gain and a net loss is treated as an ordinary loss. This kind of conditional treatment cannot be modeled; 100 percent of any gain or loss from machinery sales is treated as ordinary income in the model. Similarly, any capital losses from land sales are subject to capital gains treatment in the model, although the tax rules actually allow a limited amount of

the losses to offset ordinary income. Taxable income is restricted to be nonnegative to facilitate calculation of the firm's income tax liability.

Five scenarios of the firm's optimization problem are formulated by varying tax rules. Scenario 1, the base scenario, utilizes tax rules in effect on January 1, 1984. All tax provisions in the scenarios are identical with these exceptions: in scenario 2, the investment credit is eliminated; in scenario 3, extended depreciation schedules are used; in scenario 4, the tax rates are changed; and in scenario 5, all of the individual changes from scenarios 2, 3, and 4 are included. The specific tax provisions applied in each scenario are described in the discussion of the scenarios. The relevant tax rules are in effect over the firm's entire planning horizon, 1981 through 1988.

Results

The effects of tax simplification provisions on farm firm decision making are determined by comparing the results of the representative farm's optimization problem under varying sets of tax rules. The optimization problem is solved using MINOS 5.0 (Murtagh and Saunders). MINOS is a state-of-the-art nonlinear programming algorithm. The simplest formulation of the model contains 484 nonlinear variables, 579 linear variables, 48 nonlinear constraints and 717 linear constraints. MINOS does not have an integer programming option; thus, all variables, including machinery purchases and sales, are solved in fractional units. Until further methodological advances are made in nonlinear programming, this potential limitation cannot be addressed. The long-term effects of the varying tax provisions are summarized in table 1.

Scenario 1

Scenario 1 is based on the federal income tax rules in effect as of January 1, 1984. The tax rates, as enacted by the Economic Recovery Tax Act of 1981 (ERTA), are modeled with their phased-in format. The tax brackets are indexed, beginning in 1985. Depreciation deductions are determined in accordance with ACRS, as specified by ERTA and modified by the Tax Equity and Fiscal Responsibility Act of 1982. Thus, the

Table 1. Financial Conditions and Decisions Of Representative Farm By Tax Rule

Measure*	Initial Period	Scenarios**				
		1	2	3	4	5
Firm Net Worth	2,559,336	1,994,192	1,974,246	1,978,905	2,084,196	2,055,672
Land Value	2,688,000	2,313,878	2,286,566	2,254,385	2,047,030	2,437,392
Total Land Purchases	—	286,492	257,404	223,410	0	420,998
Machinery Value	217,667	121,423	96,382	72,258	100,739	62,110
Total Machinery Purchase	—	255,438	209,897	176,946	215,990	81,253
Savings	19,000	81,816	73,806	95,437	266,618	107,160
Total Debt	365,331	385,136	346,356	308,913	207,076	406,612
Debt/Asset	.12	.16	.14	.13	.09	.16
Income Tax Liabilities	—	273,352	321,328	291,910	242,660	253,080
Total Acreage Planted for All Years	—	8,000	8,000	8,000	8,000	7,920

*All dollar values for scenarios 1 through 5 pertain to the terminal period or the entire planning horizon and are expressed in present value terms. Net worth is measured by the market value of all assets less liabilities. Used machinery is valued according to resale price relationships published in the *Agricultural Engineer's Yearbook*.

**Scenario 1 is based on the federal income tax rules in effect as of January 1, 1985.

Scenario 2 is based on the same federal income tax rules as in Scenario 1, except that the investment tax credit is eliminated.

Scenario 3 is based on the same federal income tax rules as in Scenario 1, except that ACRS is replaced by a more extended depreciation schedule as proposed by the treasury.

Scenario 4 is based on the same federal income tax rules as in Scenario 1, except that the tax rates are consolidated into three brackets as proposed by the treasury.

Scenario 5 is based on the same federal income tax rules as in Scenario 1, except that all of the changes in Scenarios 2, 3, and 4 are incorporated.

machinery included in the model is depreciated over five years. Firms have the option of deducting 50 percent of the investment credit from the depreciable basis of an asset or reducing the applicable investment credit rate by two percentage points. The latter option is applied in the model; the investment credit is reduced from 10 percent to eight percent for machinery purchases. No first-year expensing is applied to the machinery expenditures. Sixty percent of any long-term capital gains is excluded from taxation.

The results of the planning problem indicate that the firm's net worth decreases 22 percent over the planning horizon; its annual rates of return are less than the discount factors used in the model. The model perceives excess capacity in the initial stock of machinery (due to the lack of integer restrictions) and sells a portion of this machinery quickly. The firm replaces all of its initial stock of machinery by 1986.

The firm leases increasing amounts of land and purchases new land. Because of the deterministic nature of the model, the firm has the benefit of knowing that land prices decline sharply in 1984. All land purchases

occur in 1984 and 1985; they are constrained by the availability of funds for a down payment. No land is sold. The firm's crop production increases by the maximum allowable acreage (80 acres) each year.

Although the firm experiences one year of negative net cash flow, its savings balance more than quadruples, in present value terms, by the terminal period. It does not obtain any equity refinancing. During the planning period, the firm's marginal tax rate fluctuates within the top one-third of the federal tax brackets. The present value of the firm's federal and state income tax liabilities over the planning period totals \$273,352. All subsequent scenarios are compared with scenario 1; only relevant differences are noted.

Scenario 2

All assumptions in scenarios 1 and 2 are the same except for the elimination of the investment tax credit in scenario 2. This change causes the firm's net worth in the terminal period to be one percent less than that under the current tax rules (scenario 1). With no investment credit, the firm has less savings for a down payment and buys less

land than in scenario 1. The present value of its machinery purchases is 18 percent less than under the current tax rules. The reduction in machinery purchases is due to the decreased purchasing ability and the increased after-tax cost of the expenditures. Because of the reduced land and machinery purchases, the firm's debt balance in the terminal period is 10 percent lower than in scenario 1; and the firm's savings balance is also 10 percent lower. With fewer deductions in scenario 2, the firm's marginal tax brackets in scenario 2 are never lower than those in scenario 1. The present value of all income tax liabilities increases 18 percent with the elimination of the investment tax credit.

The firm's cropping patterns are identical in scenarios 1 and 2 until the terminal period. The variation is due to differences in machinery capacity; however, total acreage planted is the same.

Scenario 3

The only difference among the parameters in scenarios 1 and 3 is the substitution of the Treasury's proposed depreciation schedule in place of ACRS. The Treasury's proposal extends the depreciation period for the machine types identified in the model from five years to 12 years and generates depreciation deductions equal to 18 percent of the declining balance, adjusted for inflation. Although the first year depreciation rate is higher in the Treasury's proposal, the present value of the depreciation deductions under the Treasury's proposal is 15 percent less than the ACRS deductions.

In scenario 3, the firm's net worth is one percent lower than that in scenario 1. The slower depreciation schedule increases the firm's tax liabilities and reduces the funds available for capital expenditures. The present value of the land purchases are 22 percent lower than in scenario 1. The decrease in machinery purchases is even greater—31 percent. Machinery purchases are so unprofitable and/or restricted that the firm continues to operate some of the original machines with high repair costs (tomato harvesters and crawlers) throughout its planning period.

Unlike scenario 1, the firm obtains a small amount of refinancing. This refinancing

increases the amount of land purchased by the firm in the following period and generates interest deductions which lower the firm's marginal tax rate in each of the following three years. The firm owes less in scenario 3 than in scenario 1, due to the reductions in land and machinery purchases. The firm has lower deductions in scenario 3 than in scenario 1; its marginal tax brackets in scenario 3 are never lower than those in scenario 1. Although its total tax liabilities are 7 percent higher, the firm's diminished amortization requirements provide a 17 percent increase in savings in the terminal period from the level in scenario 1.

The total acreage farmed is identical in both scenarios 1 and 3. There are minor variations in the crop mix in the final year due to differences in machinery capacity.

Scenario 4

In scenario 4, the tax rates are different from those in scenario 1. The current 16 income brackets are collapsed into three in accordance with the Treasury's proposal. The brackets are indexed to inflation. The values of personal exemptions and the standard deduction are increased as proposed by the Treasury. These changes increase the firm's terminal net worth by five percent.

The revised tax rates reduce the tax savings generated from interest deductions to the extent that the firm does not purchase any land. It purchases 15 percent less machinery in present value terms. Because of the reduced purchases, the firm's debt balance is substantially lower than that under the current tax rules and its savings balance is correspondingly higher. The increased savings are also attributable to an 11 percent decrease in the present value of the firm's total income tax liabilities. In all but two years, the firm is taxed at the highest marginal tax rate.

The firm's cropping decisions are identical in scenarios 1 and 4. All expansion occurs on leased land under the collapsed rate structure.

Scenario 5

The changes in tax rules that are considered individually in scenarios 2, 3, and 4 are all included in scenario 5. The net

effect of these revisions is to increase the terminal value of the firm by three percent. Consolidating tax rates increases the funds available for investment. Eliminating the investment tax credit and extending machinery depreciation periods reduce the attractiveness of investing in machinery relative to land. As a consequence, land purchases increase by 47 percent and machinery purchases decrease by 68 percent in present value terms from their respective levels under current tax rules. The firm would have purchased more land if additional funds had been available for a down payment.

Due to the increased land purchases, the firm's debt balance is higher than in scenario 1. However, its savings balance is also higher; this is attributable to the eight percent decrease in the present value of the firm's income tax liabilities. These tax liabilities are four percent higher than those in scenario 4, because of the extended depreciation periods and elimination of the investment tax credit. The firm is in the highest tax bracket in all but one year.

Cropping decisions are identical in scenarios 1 and 5 until the final year. Because machinery purchases are substantially diminished as a result of the combined tax changes, the firm's machinery capacity is reduced to the point that it cannot expand production in the final period. It is more profitable for the firm to have the restricted production capacity rather than change its investment decisions to provide for increased crop production.

Concluding Comments

This analysis examines the impact of major income tax simplification proposals on California crop farms but it is not exhaustive due to model and time limitations. A major revision in the Treasury's proposal concerning elimination of the special treatment of long-term capital gains is not evaluated because the firm does not sell any land. Selling land is not profitable; the proposed revision makes it even less profitable. There are no other activities in the model that yield capital gains. The tax treatment of capital gains income, however, would be an important aspect of a model for a livestock operation.

Proposals to change the tax treatment of interest expenses, which could take any of several forms, are not analyzed. Restricting the deductibility of interest will reduce debt financing of investments in land and machinery; the degree of reduction will depend on the form of the restriction. Income tax simplification will have differential impacts by size of farm firm (Hardesty), with the relative impact being a direct function of income level. These differential impacts are a topic for future research as the analytical model is refined.

The provisions included in tax simplification proposals affect both the firm's ability and incentive to invest in land and machinery. Eliminating the investment tax credit and extending the depreciation period for durables resulted in decreased machinery purchases and increased income tax liabilities, as expected. The consolidation of income tax rates into three brackets also resulted in a small decrease in machinery purchases due to reduced tax savings from interest deductions. The most dramatic impact of the new rate structure, taken alone, was to reduce land purchases to zero. Total taxes paid under the new rate structure were also reduced significantly.

Interactions between tax provisions resulted in surprising differences in the firm's decisions when tax changes were considered collectively. Machinery purchases were reduced in each of the scenarios 2 through 4 but the collective impact of all the tax changes was to decrease machinery purchases by 68 percent of those existing in the base model. Land purchases were also reduced from the base in scenarios 2 through 4 (to zero in scenario 4) but increased 47 percent over the base when all of the tax changes were considered simultaneously in scenario 5. The attractiveness of land investments relative to machinery investments increased significantly.

Collectively, the major provisions in the Treasury Department's tax simplification proposal would improve the representative crop farm's net worth, increase both savings and debt for land purchases, and decrease total taxes paid. The combined results of this study indicate that the Treasury Department's proposal would lead to further significant

decreases in the demand for farm machinery together with increased pressure for farm expansion and increased demand for farm land. The combined results also indicate the importance of considering a total package of tax law changes in any analytical model. Because of interactions, the impact of separate tax law changes may cancel each other or they may be multiplicative.

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Do FmHA Employees Undervalue Land? A Test in Indiana

Thomas E. Atkinson, Deborah J. Brown, and Kim Cook

Abstract

Land value survey respondents differ in affiliation and job classification from survey to survey. Do these variations bias the survey results? A test of the Indiana Land Value Survey indicates that an apparent undervaluation of farm land by FmHA employees and an apparent overvaluation by bankers disappears when correction is made for geographical location.

Key words: land value survey, contingency table analysis, survey bias.

Land value surveys are conducted by the USDA, the Federal Reserve Bank, and by several states including Indiana. Lending institutions, bankers, attorneys, farm managers, owners, and operators often rely on the results of such surveys in buying, in selling, in financing land sales, in setting land rents, and in determining tax liabilities for estate planning. Therefore it is important that the job or affiliation of the respondents not bias the results of the surveys.

This article describes how contingency table analysis was used to test the 1982 Purdue land value survey for such bias. The technique can be applied without difficulty to other surveys since the test statistic is calculated easily by hand or by using readily available computer packages.

The Survey

Choosing the Sample

The Purdue University rural land values survey has been conducted annually since 1972. The mailing consists of an explanatory cover letter and the questionnaire (see figure 1). Respondents are asked to complete questionnaires for one or more counties in which they work. The principal questions request information about average corn yields, bare land cash rental rates, and land values over a six-month period for top, average, and poor farmland.

Included in the survey sample are representatives of the major farm lenders—banks, Production Credit Associations, the Federal Land Bank (through the Federal Land Bank Associations), the Farmers Home Administration, life insurance companies—and individuals engaged in farm

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Table 1. Categorization of Respondents

Principal Job Function (Total number)	Place of Employment					ROW TOTAL
	PCA (78)	FLBA (67)	FmHA (30)	BANK (51)	Misc. (38)	
Real Estate Broker (6)	0	0	0	0	6	6
Farm Appraiser (7)	0	0	0	0	7	7
Farm Loans (179)	76	66	25	11	1	179
Farm Manager (7)	0	0	0	2	5	7
Banker (31)	2	1	0	28	0	31
Other (2)	0	0	0	0	2	2
Combination (32)	0	0	5	10	17	32
Column Total	78	67	30	51	38	264

management, appraisal, and real estate sales.¹

Use of Survey Results

The results of the survey are distributed in a number of ways. An article outlining the findings appears in the *Purdue Agricultural Economics Report*, which has a circulation of about 7,000. In addition, reprints of the article are used for classes and conferences held at Purdue, and a number of newspaper and farm magazines publish articles based on the survey results.

Checking for Biases

Given the widespread use of the survey, it is especially important to check for bias. If there were groups within the sample that rated values and yields differently than the

rest of the population and these groups were overrepresented among the survey respondents, the survey results would not be a valid representation of the ratings one would obtain from the population as a whole. There was particular concern that respondents with different employment affiliations or job functions might consistently over- or undervalue land.

To test for bias, each of the 278 respondents to the 1982 survey—which had a 50 percent response rate—was classified three ways: place of employment; principal job function within the institution; and geographic region. Table 1 illustrates the breakdowns.

Land value estimates that were considered "high" or "low" were then identified for each of the three land classes.² A high land value estimate is defined as one that is above the average estimate of the highest 50 percent of the estimates for that particular land class. A low land value estimate is one that is below the average estimate of the lowest 50 percent of the estimates for that particular land class.

The data were then arranged in two-way contingency tables that classify respondents by these characteristics.

Table 2 is one of the resulting contingency tables. This particular table classifies survey responses by place of employment versus

¹With regard to PCA, FLBA, and FmHA, persons working directly with farmers at the local level were the primary contact. In many cases, there was only one person per county representing each of these organizations. Sometimes the same person represented more than one county. Personnel directories were obtained from the FmHA, PCAs, and FLBAs. Bankers surveyed were those who were members of the Indiana Agribankers Association plus a few others who were known to be interested and cooperative. Farm loan representatives of life insurance companies were identified through their membership in the Indiana Chapter of Farm Managers and Rural Appraisers or by personal acquaintance. Names of real estate brokers were obtained from their trade association, the Farm Managers and Rural Appraisers membership list, and personal acquaintance. Additional information about the Purdue Land Value Survey which is conducted annually, can be obtained from J.H. Atkinson, Department of Agricultural Economics, Purdue University.

²Bishop, Fienberg, and Holland (1978) discuss techniques for contingency table analysis where some cells have expected values of zero.

Table 2. Place of Employment Versus High and Low Estimates of Land Values—Top Land

Place of Employment	Low ^a Land Value Estimate	High ^b Land Value Estimate	Row Total
PCA	11 ^c (15.7)	21 (16.3)	32
FLBA	13 (11.3)	10 (11.7)	23
FmHA	14 (8.3)	3 (8.7)	17
Bank	8 (8.8)	10 (9.2)	18
Misc.	4 (5.9)	8 (6.1)	12
Column Total	50	52	102

Significance, 1.6%.

^aLow defined as below \$854 per acre for poor land, \$1,347 per acre for average land, \$1,763 per acre for top land.^bHigh defined as below \$1,546 per acre for poor land, \$2,084 per acre for average land, \$2,634 per acre for top land.^cThe top number in each cell is the number of respondents observed with these characteristics. The number in parentheses in each cell is the number of respondents we would expect to observe if place of employment and land value were independent.**Table 3. Place of Employment Versus Low and High Estimates of Land Values—Average and Poor Land**

Place of Employment	Average Land		Total	Poor Land		Total
	*Low	High		Low	High	
PCA	14 ^b (15.12)	14 (12.85)	28	21 (21.98)	18 (17.02)	39
FLBA	13 (10.26)	6 (8.74)	19	8 (8.45)	7 (6.35)	15
FmHA	14 (9.18)	3 (7.82)	17	13 (9.02)	2 (6.98)	16
Bank	9 (12.42)	14 (10.58)	23	12 (13.53)	12 (10.47)	24
Misc.	4 (7.02)	9 (5.98)	13	8 (9.02)	8 (6.98)	16
Total	54	46	100	62	48	110

Significance, 1.6%.

^aLow and high bids are defined in table 2.^bThe top number in each cell is the number of respondents observed with these characteristics. The number in parentheses in each cell is the number of respondents we would expect to observe if place of employment and land value were independent.

Significance, 30.4%.

high and low land value estimates on top land. The top number in each cell in table 2 is the number of observed survey respondents in that category. For example, there are 11 respondents who worked for PCA and had low land value estimates for top land.

The bottom number in parentheses in each

cell in table 2 is the number of respondents one would expect to observe in that cell if the categories by which the data have been classified are independent. For example, if employment at PCA is independent of making a low land value estimate, the expected number of respondents in the first cell of table 2 would be 15.7.

The question is whether the differences between observed and expected values are significant—if they indicate that place of employment and a high or low land value estimate are not independent. A chi square (χ^2) test of independence yields a significance level for table 2 of 1.6 percent, indicating that place of employment and high or low land value estimates for top land are not independent at a significance level of 1.6 percent.³

Table 3 shows contingency tables of place of employment versus estimated land values for average and poor land. χ^2 tests here indicate

³The test statistic, which is distributed χ^2 with $(R-1)(C-1)$ degrees of freedom, is

$$Q = \sum_{i=1}^R \sum_{j=1}^C \frac{(N_{ij} - E_{ij})^2}{E_{ij}}$$

where there are R rows and C columns in the contingency table, N_{ij} is the observed value in the cell of row i , column j , and E_{ij} is the expected value—assuming independence—in the cell of row i , column j . The expected value is calculated as

$$E_{ij} = \frac{N_{i.} \cdot N_{.j}}{n}$$

where $N_{i.}$ is the sum of the observed values in the cells of row i , and $N_{.j}$ is the sum of the observed values in the cells of column j , and n is the number of respondents. These calculations are described in numerous statistical texts. See, for example, DeGroot (1975).

that place of employment and land value estimates are not independent at the five percent significance level for average land either, although they are independent for poor land.

The χ^2 significance tests are for the contingency table as a whole. Individual cells in the table can be examined, however, to determine which contributed the most to the χ^2 statistic, in other words, which groups tended to have unexpectedly low or high estimates. In the case of employment and land values, PCA employees tended to make noticeably fewer low estimates and more high estimates on top land than one would expect to observe if place of employment and land value estimates were independent. Similarly bank employees tended to make noticeably fewer low and more high estimates on average land than one would expect. FmHA employees tended to make both more low and fewer high estimates on all land classes. This last result—very noticeable and crossing all land classes—is particularly worrisome as an indication of possible survey bias.

Before concluding however that FmHA employees undervalue land, the authors examined the possibility that the group's geographic location was causing this variation. Perhaps a disproportionate number of FmHA respondents were located in

Table 4. Place of Employment Versus High and Low Estimates of Land Values in Southeastern Indiana

Place of Employment	Top Land		Total	Average Land		Total	Poor Land		Total
	Low ^a	High ^b		Low	High		Low	High	
FmHA	3 ^c (1.8)	0 (1.2)	3	7 (14.7)	0 (2.3)	7	7 (5.5)	0 (1.5)	7
Other	4 (5.2)	5 (3.8)	9	7 (9.3)	7 (4.7)	14	8 (9.5)	4 (2.5)	12
Total	7	5	12	14	7	21	15	4	19

Significance, 15.9%.

Significance, 7.2%.

Significance, 12.8%.

^aLow defined as below \$600 per acre for poor land, \$947 per acre for average land, \$1,302 per acre for top land.

^bHigh defined as above \$1,011 per acre for poor land, \$1,587 per acre for average land, \$2,011 per acre for top land.

^cThe top number in each cell is the number of respondents observed with these characteristics. The number in parentheses in each cell is the number of respondents we would expect to observe if place of employment and land value were independent.

counties with inferior farm land.

As a first test of this possibility, a list of the counties for which FmHA personnel estimated low values was obtained, and the average Census of Agriculture land value for these counties was calculated. The resulting figure is 32 percent below the census's statewide land value average, indicating that FmHA employees were located in counties with lower than average land quality.

This first test is not altogether satisfactory however, because Smith and Raup have

shown that in Minnesota the 1974 and 1978 Census of Agriculture tended to overvalue poor land and undervalue good land. Such a bias could be the effect of differing responses by farmers to changing land prices, with farmers on poor land slower than the others to respond to changes. Since prices were rising when Smith and Raup made their study, but decreasing when the 1982 Indiana land survey was made, it is not clear what the direction of any bias in the agricultural census land values might be. A second test was therefore performed on the data from a section of Indiana which has

Table 5. Job Function Versus Low and High Estimates of Land Values

Job Function	Top Land		Total	Average Land		Total	Poor Land		Total
	Low ^a	High		Low	High		Low	High	
Real Estate Broker	0 ^b (.99)	2 (1.01)	2	0 (1.08)	2 (.92)	2	2 (1.66)	1 (1.34)	3
Farm Appraiser	1 (2.48)	4 (2.52)	5	1 (3.23)	5 (2.77)	6	1 (3.31)	5 (2.69)	6
Farm Loans	37 (35.66)	35 (36.34)	72	41 (34.46)	23 (29.54)	64	44 (39.72)	28 (32.28)	72
Farm Manager	0 (.50)	1 (.50)	1	0 (1.08)	2 (.92)	2	0 (1.10)	2 (.90)	2
Banker	4 (5.94)	8 (2.06)	12	3 (7.54)	11 (6.46)	14	4 (6.62)	8 (5.38)	12
Combination	10 (6.44)	3 (6.56)	13	11 (8.08)	4 (6.92)	15	13 (11.03)	7 (8.97)	20
Total	52	53	105	56	48	104	64	52	116
Significance, 7.7%.				Significance, 0.2%.			Significance, 7.2%.		

^aLow and high bids are defined in table 2.

^bThe top number in each cell is the number of respondents observed with these characteristics. The number in parentheses in each cell is the number of respondents we would expect to observe if job function and land value were independent.

Table 6. Job Function Versus High and Low Estimates of Land Values in West Central Indiana

Place of Employment	Top Land		Total	Average Land		Total	Poor Land		Total
	Low ^a	High ^b		Low	High		Low	High	
Banks	3 ^c (3.4)	3 (2.6)	6	4 (3.1)	3 (3.9)	7	4 (2.5)	2 (3.5)	6
Other	9 (8.6)	6 (6.4)	15	3 (3.9)	6 (5.1)	9	7 (4.5)	10 (6.5)	11
Total	12	9	21	7	9	16	7	10	17
*Significance, 100%.				Significance, 32.9%.			Significance, 14.5%.		

^aLow defined as below \$1,010 per acre for poor land, \$1,520 per acre for average land, \$1,963 per acre for top land.

^bHigh defined as above \$1,756 per acre for poor land, \$2,226 per acre for average land, \$2,690 per acre for top land.

^cThe top number in each cell is the number of respondents observed with these characteristics. The number in parentheses in each cell is the number of respondents we would expect to observe if job function and land value were independent.

^dA Two by Two Table can be calculated by Fisher's Exact Test.

generally poorer quality land (southeastern Indiana). Table 4 gives the results of this test. The table shows that although FmHA employees in southeastern Indiana had more low and fewer high land value estimates than other survey respondents, the difference was not significant at a five percent level. It would appear that the FmHA personnel who had "underestimated" land values were justified in doing so because of their geographic distribution in regions of poor quality farmland.

A similar analysis was performed on contingency tables of job function versus low and high land value estimates. The results are shown in table 5. Bankers were found to have noticeably more high and fewer low value estimates over the three land classes. As in the case of place of employment a geographic comparison using agricultural census figures was used to determine if the bankers were "justified" in their high estimates. The specific counties from which their overestimates came had an average land value 15 percent higher than the statewide average.

Since the direction of possible bias from the agricultural census data was unknown, a second test was performed on the data from a section with generally higher land quality (west central Indiana). The results are shown in table 6. The table shows that there was no significant difference between bankers and other respondents in the number of high land values in this high land value region. Again we can state with reasonable assurance that the bankers were justified in reporting a larger than expected number of high estimates.

It therefore appears that at least in one land value survey, estimates of land value are independent of place of employment and job function once geographical differences are considered.

Conclusion

This paper describes the use of a technique for checking a land value survey for bias. The example used is the 1982 Purdue Land Value Survey. The technique is contingency table analysis. The analysis indicated that, in this survey, neither place of employment nor job function significantly affected estimates of land value once geographical differences were considered.

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Figure 1. The Questionnaire

Please return by July 1, 1982 to: NAME: _____
 Dr. J. H. Atkinson
 Dept. of Ag. Econ. ADDRESS: _____
 Purdue University
 West Lafayette, IN 47907 _____

CROPLAND VALUES AND CASH RENTS—1982

The following data on farm real estate values are for:

1. _____ County
2. My job is primarily that of: a. _____ real estate broker, b. _____ farm appraiser, c. _____ farm loans, d. _____ farm manager, e. _____ banker, f. _____ other
3. In the table below, please give your estimate per acre of (1) long-term average yields, (2) the market value of *bare cropland* in December 1981, June 1982, and your guess for December 1982, (3) the market value of land which is moving into nonagricultural uses, and (4) bare cropland cash rent for 1982.

Quality of Farmland	Average Corn Yield Bu/A ^a	December 1981	June 1982	December 1982	1982 Land Cash Rent/Acre
Top	_____ a/	\$ _____	\$ _____	\$ _____	\$ _____/
Average	_____ a/	\$ _____	\$ _____	\$ _____	\$ _____/
Poor	_____ a/	\$ _____	\$ _____	\$ _____	\$ _____/
Transition ^b Land		\$ _____	\$ _____	\$ _____	

^aLong-term average corn yields with typical farming practices.

^bAreas where much of the land is moving into residential, commercial, and industrial use.

4. What is your estimate of the annual average on-farm corn and bean prices, farm mortgage interest rates, and inflation rates for the five-year period 1982-1986?

#2 Corn: \$ _____ per bushel Soybeans: \$ _____ per bushel

Mortgage interest rate _____ Inflation rate _____

5. From current levels, where do you expect land prices to be five years from now?
(Check and give percentage estimate where appropriate.)

_____ Up, by _____% _____ No change _____ Down, by _____%

6. What changes are taking place in leasing arrangements as a result of the "financial squeeze" in farming?
Use back of page if necessary.

A Linear Programming Analysis of the Regulatory Response of Rural Banks in the Philippines

Donald W. Larson, Severino B. Vergara, and Warren F. Lee

Abstract

The Philippine government through the Central Bank has tried to influence the rural banks' allocation of funds in favor of small farmer loans through changes in regulatory policy. A linear programming model was developed to evaluate changes in the small farm loan portfolio resulting from selected regulatory changes. Results indicate that neither seed funds to support supervised credit programs nor preferential interest rates on rediscounted funds for agricultural loans increase the flow of credit to small farmers. Such policies increase bank profits, discourage banks from mobilizing local deposits, and increase their dependence on Central Bank rediscount funds.

Key words: Philippines, small-farmer credit, rural banks, linear programming.

An increase in the supply of institutional credit to the agricultural sector, particularly the food sector which is dominated by the small farmers, has been one of the policy objectives of the Philippine government to achieve increased agricultural productivity and more equitable income distribution during the last two and a half decades. The most well known of these programs is the Masagana 99 (M99) program launched in 1973 to achieve self-sufficiency in rice production. M99 integrated under one umbrella low cost production credit as a vehicle for income transfers to small rice farmers, a fertilizer subsidy, price support, technical assistance, and other agricultural support services (Esguerra). In addition, the government, through the Central Bank (CB), initiated the development of the rural banking system. The CB provided tremendous technical and financial support to ensure the viability and success of the rural banks. At the same time, it has tried to influence the rural banks' allocation of funds in favor of small farmer loans through changes in the regulatory policies. No previous study has been conducted to analyze the effects of those policies on the allocative behavior of banks.

The objectives of the present study are: (a) to determine the profit-maximizing level of small farm loans of a representative rural bank, given the available alternative assets, internal operating constraints, regulatory policies of the CB, and other external constraints, and (b) to evaluate the changes in the small farm loan portfolio of a representative rural bank resulting from changes in selected regulatory policies.

Donald W. Larson is a professor, Severino B. Vergara is a former graduate student, and Warren F. Lee is a professor in the Department of Agricultural Economics and Rural Sociology at The Ohio State University. The authors express their appreciation to three anonymous journal reviewers for helpful comments.

The Analytical Approach of the Study

Linear programming (LP) is the analytical approach employed to achieve the objectives of this study. The assumption of profit maximization for the bank and the linearity of all the constraints facing the bank suggest the suitability of the LP technique for the present study. A multiperiod model is used to avoid suboptimal decisions which might result from a myopic view that ignores the relevant aspects of the future. The bank is assumed to have a one-year planning horizon that is partitioned into 12 monthly planning periods. The choice of the monthly planning periods was dictated in large part by the fact that rural banks are required by the CB to submit monthly financial statements used to determine compliance with the regulatory constraints imposed on them. These constraints are discussed in the next section of this paper.

The general form of the LP model estimated in this study is:

$$\text{Maximize } \pi = \sum_{t=1}^{12} \left(\sum_i r_i A_{i,t} + \sum_j C_j L_{j,t} + FC_t \right)$$

$$\text{subject to: } R_{kt} (A_{i,t} - L_{j,t}) \leq \beta_{kt}$$

where π = expected net profit during the planning horizon.

r_i = expected net return on asset i .

C_j = expected cost of liability j .

$A_{i,t}, L_{j,t}$ = average stock of asset i and liability j , respectively, during period t .

R_{kt} = coefficient matrix for individual asset and liability accounts associated with constraints K at time t . ($K = 1, \dots, n$;
 n = number of constraints).

β_{kt} = vector of stipulations associated with constraints k at time t .

FC_t = fixed costs at time t .

As formulated above, the objective function used is the maximization of the monthly flows of net profit or income. This is equivalent to the maximization of the return on stockholders' equity (ROE) at the start of the planning period since it is assumed that there is no capital expansion through the sale of new shares of stock; i.e., reinvestment of profits is the only source of additional capital in the model.

The model is not meant to accurately describe the detailed behavior of the banks; nor is it intended to generate results needed in the day-to-day decision making of the bank managers. Rather, it is an analysis of the effects of changes in specific regulations on the balance sheet choices of the banks. This study attempts to simulate the actions of a bank manager who does not use sophisticated models for choosing the portfolio. Thus, it seems reasonable that a model including only the kind of knowledge and expectations a manager might have would be preferred over more complicated models.

While profit maximization is the goal assumed in this study, it does not mean that it is the only goal pursued by the firm. Bank firms in fact, are assumed to have other goals but with profit maximization as the dominant goal. In a sense, the other goals act as constraints to profit maximization. A liquidity goal and the maintenance of a certain-level-of-risk goal are just some of the other legitimate goals of the bank. This recognition of multiple goals for the banking firm has led some researchers to suggest a goal or lexicographic programming approach to study bank behavior (Keown). The difficulty with this approach is that it requires specification of the priority-weighting structure among the different goals identified in the model, a task which could very well form a separate study in itself.

As Cohen and Hammer report, there are alternative choices for consideration in the specification of the objective function to use in a bank behavior model: (a) maximize the value of the stockholder's equity during the final period of the planning horizon; (b) maximize the present value of the net income stream plus realized capital gains (and losses) during the planning horizon; and (c) maximize the present values of the

net income stream plus realized capital gains (and losses) during the planning horizon plus the present value of the stockholders' equity during the final period of the planning horizon. Obviously, these choices are more appropriate for banks whose capital stocks are being traded in the stock market, as in the case of large commercial banks. This is not the case, however, for rural banks in the Philippines. These banks are closely held corporations and although the sale of new stocks and stock transfers is allowed, these transactions are regulated by the CB. In practice, a majority of the stock transfers and new stock sales are transacted among the existing stockholders and their families.

In contrast to the above specifications of the objective function which are in terms of present value, the objective function for the rural banks in our model is in terms of current values. For a one-year planning horizon the differences between discounted and nondiscounted values would be slight, so that the use of nondiscounted values may slightly overstate profits. Except for medium and long-term loans which account for a very small share of Philippine rural bank loan portfolios, all the asset activities in the model have maturities of less than one year. Also, interest income is assumed to be deducted in advance for all loans. Hence, the problem introduced by not using present value originates mainly from the differences in the monthly repayment flows among the loan variables.

The Constraints in the LP Model

The profit-maximizing goal of the bank is restricted by three categories of constraints: those imposed on it by the regulatory authorities, the *regulatory constraints*; those that are related to the market, the *market constraint*; and a *funds-availability constraint* used merely to specify that total uses of funds equal total funds available.

Regulatory Constraint¹

Reserve requirement. The required reserve

is 14 percent for demand deposits and eight percent for time and savings deposits. At least 10 percent of the total required reserves must be in the form of cash deposited with the CB. The balance of the required reserves may be held in the form of vault cash and/or CB-supported securities. However, holding securities eligible as reserves cannot exceed 18 percent of the total required reserves (or 20 percent of the maximum 90 percent allowable reserves held in the form of CB-supported securities and/or vault cash).

Risk-to-asset ratio. By regulation, a rural bank must maintain a risk-to-asset ratio of not less than 10 percent. This ratio is computed by dividing total assets less risk-free assets by capital funds. Risk-free assets include cash on hand and due from banks, CB-supported securities, loans secured by deposits, bank premises, furniture, fixtures and equipment, and supervised credit loans covered by guarantee.

Operating capital ratio. The bank's operating capital (cash on hand plus the amounts due from the CB and from other banks) must be less than or equal to 40 percent of total deposit liabilities (exclusive of special deposits). This requires that the bank reduce its own liquid assets to this level before borrowing from the CB.

Past-due loan ratio. The ratio of past-due loans to the total loans outstanding of the bank cannot exceed 25 percent if the bank is to avail itself of the special rediscounting privilege with the CB as well as other privileges. Excluded from past-due computation are loans covered by guarantee and M-99 loans in litigation (since M-99 loans are most likely to be covered by guarantee, guaranteed loans must be excluded to avoid double counting.)

Rediscounting constraints. There are two separate ceilings on the amount of loans that rural banks can rediscount with the CB. The ceiling depends on whether or not the loans are supervised. For supervised loans, the rediscounting limit is 400 percent of net worth plus 100 percent of monthly average savings and time deposits (STD) during the three months immediately preceding the date of rediscount application. The corresponding figures for nonsupervised loans are 200 percent of net worth plus 50 percent of

¹The bank-premises ratio and the furniture, fixture, and equipment ratio were not included in the model but are a part of the total assets. It was assumed that there will be no purchase and sale of these assets during the programming period.

monthly average STD. All of the outstanding balances of supervised loans can be rediscounted with the CB, but only 80 percent of nonsupervised loans can be discounted. Only loans with original maturities of less than one year are rediscountable.

Market Constraints

Loans. In the context of rural financial markets in the Philippines, interest rate ceilings on loans are set by the CB and typically these rates have been less than the annual rate of inflation. The low, even negative, real rates of interest on these loans lead to an excess loan demand from potential borrowers and credit rationing by lenders (Adams). Regulators attempt to influence rural bank lending by changing the spread between the fixed lending rate and the bank's cost of funds. In the model it is assumed that the bank will not lend more than is forecast in any loan category during any period. This implies that there is no incentive for banks to compete for loans in general. However, for certain loans, specifically those with low default risks, some degree of competition may be present depending on the structure of the market. Therefore, the forecast should be linked to a certain level of loan risk. Beyond this forecast, the bank is restricted by risk considerations from further lending, and hence, will simply say "no" to particular loan requests. There is a real need to specify the market limits on the loans in the model. Since it is likely that net rates of return among types of loans would differ, the model operates such that, *ceteris paribus*, all the available funds will be channeled into loans offering the highest return. Loan demand forecasts were based on the amounts granted by the bank in the previous year with a 20 percent upward adjustment for the expected rate of inflation and additional increases in real loan demand.

Investments. Except for equity investments, there are no market constraints on the amount of new investments a bank can make during each period. It is assumed that the supply of government securities and money market instruments is infinitely elastic. Equity investments are regulated very strictly by the CB and for our purposes they can be assumed to be zero. Of course, the reduction

or sale of investment assets is constrained by the initial amount available.

Deposit variables. As in the case of loans the increase in deposit variables is limited to the forecast levels during the period. The variables are measured in terms of net monthly balance so there is no need to include another set of variables to represent withdrawals, new accounts, interest credits, and so forth, in the model. Intertemporal relationships are of prime importance in a multiperiod model since they express the interdependence of variables over time. This is particularly true with respect to the maturity of the accounts, and hence, the associated liquidity flows. In addition to maturity flows, an autonomous flow variable is associated with each account at each time period. When the flow is positive, the account is accumulating; when the flow is negative, the account is being depleted. Asset and liability flows are assumed to take place at constant rates during the period. Under this assumption, purchases, sales, and maturations of assets are presumed to occur at constant rates during the period and hence the rate of change in the stocks of the balance sheet accounts themselves will be constant over time. The advantage of this assumption is that the average stock of an account during a period can be defined simply as the arithmetic mean of the initial balance and the end-of-period balance.

Default risks on each loan are assumed to be independent, and default risks across types of loans are also assumed independent. Although this assumption may be somewhat implausible for borrowers in the same industry, it is necessary for the independence of coefficients and constraints in the model. Default risk on the bank's investment portfolio, primarily national government bonds and Central Bank Certificates of Indebtedness, is assumed to be zero.

Determination and Selection of Sample Banks

This study was limited to banks operating in the Central Luzon region of the Philippines. A large proportion of the small farmers in the country are located in this region, and it has been a hotbed of social and political unrest in the country. The economic plight of the

small farmers in this region has consistently been accorded top priority in the government's agricultural development programs. Since the analytical thrust of the study is the identification of changes in CB policies needed to influence rural bank credit allocation in favor of the small farmers, the choice of this region as the study area is logical.

A random sample of 15 rural banks was included in the study. This constitutes over 10 percent of the rural bank population in the region (exclusive of those banks less than three-years old). After distributing the number of banks to be sampled among the six provinces in the region, in proportion to the number of rural banks operating for more than three years, the CB Agricultural Credit Supervisors (ACS) were instructed to select randomly the banks to be included in the sample. Because of the confidentiality of bank information, the selection of sample banks had to be done by the ACS assigned to the region; however, the sample selection was carefully designed and personally supervised by the researcher. One condition made in the sample selection was that the selected banks should have assets of no more than P30 million nor less than P4 million to prevent extremely small and large banks from introducing significant bias in the sample.² Data needed for the LP model were gathered through the use of a structured and pretested questionnaire.

In terms of total assets, the average size of the 15 sample banks covered in the study was P10,404,207 as of October 31, 1979 (table 1). The size varies from P4,194,084 to P22,108,270 with a standard deviation of P4,861,233. The banks are distributed with eight banks above the average, seven below it, and 10 of the 15 are within one standard deviation of the mean. The average sample bank has 84 percent of its total assets in loans, 89 percent of which are agricultural. Deposit liabilities constitute 38 percent of the total liabilities (including capital) of the average sample bank. Borrowings from the CB account for 36 percent of the total liabilities, almost 89 percent of which is in the form of rediscounting. The total capital

accounts of the average sample bank is P1,171,787, about 11 percent of total assets. The total capital account for 11 of the 15 banks is within one standard deviation of the mean. More than 45 percent of the capital is in common stocks and almost 52 percent is in undivided profits and surplus accounts. Preferred stocks account for the balance.

Table 2 shows the expected net returns on assets and the total cost of liabilities of the sample rural banks, including the estimated administrative costs of different classes of assets and liabilities and the risk of default losses of different classes of assets. Small supervised agricultural loans (SSL) have administrative costs of 1.56 percent, followed closely by small ordinary agricultural loans (SOL), 1.54 percent. Large supervised (LSL) and large ordinary agricultural loans (LOAL) involve much lower administrative costs, 0.98 percent and 0.96 percent, respectively. Medium- and long-term agricultural loans (MLL) have the highest estimated default risk, 4.3 percent, followed by SSL at 3.3 percent. The default risk associated with each type of loan was based on the bank management's estimate of default, the type of security required on loans, and an analysis of past-due loans by type for each bank.

Results

The LP bank model was solved using the average balance sheet conditions of the sample banks as of October 31, 1979. Three versions of the basic model were also solved to evaluate the impact of changes in the regulatory policies. The first version incorporated a parameterized increase of 50 percent over the original loan demands used in the basic model to deal with the uncertainties associated with the demand forecasts.³ The second version analyzed the impact of the suspension of special time deposits as a seed fund to support the supervised credit program of the rural banks. The third version examined how equalizing the interest rates on rediscount funds for supervised agricultural loans and ordinary agricultural loans (one percent and three

²The exchange rate in October of 1979 was about P9.50 per U.S. dollar.

³The loan demand forecasts have been parameterized in such a way that they cover increases of 10 percent, 20 percent, 30 percent, 40 percent, and 50 percent over the original. However, the solution values do not differ much between 10 percent and 40 percent and hence only the results for 50 percent are presented.

Table 1. The Average Balance Sheet Characteristics of the 15 Sample Rural Banks as of October 31, 1979, Central Luzon, the Philippines

<i>Assets</i>	
Cash and Due from Banks:	
Cash on Hand (CH ₀) ^a	P 106,424
Due from CB (CC ₀)	98,996
Due from other banks (COB ₀)	687,534
	892,955
Loans and Discounts	
Small supervised agricultural loans (SSL ₀)	2,015,608
Small ordinary agriculture loan (SOL ₀)	1,038,108
Large supervised agriculture loan (LSL ₀)	2,511,297
Large ordinary agriculture loan (LOAL ₀)	1,887,502
Medium- and long-term agriculture loan (MLL ₀)	370,597
Commercial loan (COM ₀)	524,392
Industrial loan (INL ₀)	249,107
Other loan (OL ₀)	164,933
Less: Allowance for probable losses	(238,455)
Net Loans and Discounts	8,523,090
Investments:	
CB Certificate of Indebtedness	
reserve eligible (ERES ₀)	56,486
nonreserve eligible (XRES ₀)	89,527
Preferred stock redemption (PSR ₀)	8,110
Agrarian Reform Credits (ARC ₀)	35,881
Other Assets:	
Bank premises (BPREM)	156,265
Furniture, fixtures, and equipment (FFE)	79,990
Other bank assets (OBNA)	
Total Assets	P 10,404,207
<i>Liabilities:</i>	
Reserve Deposits:	
Demand deposits (DD ₀)	7,748
Savings deposits (SD ₀)	2,327,666
Time deposits (TD ₀)	1,581,454
Nonreserve Deposits:	
Special time deposits (STD ₀)	712,294
Barrio Guarantee Fund (BGF ₀)	21,715
Barrio Savings Fund (BSF ₀)	78,769
Special Savings Deposits (SSDC ₀)	95,269
Bills Payable:	
Rediscounting-supervised (RED ₀)	2,783,228
Rediscounting-ordinary (REDO ₀)	570,499
CB-IBRD (IBRD ₀)	361,832
Other Bills Payable (OBIL) ^b	71,018
Other Liabilities (OLLAB ₀)	620,921
Capital Accounts (CAP ₀)	1,171,787
Total Liabilities ^c	P 10,404,207

Source: Vergara

^aThe subscript of zero (0) indicates that the figure opposite the balance sheet variable serves as the initial value of these variables during the first programming period.^bRestructured borrowings from the CB^cThe exchange rate in October of 1979 was about P9.50 per U.S. dollar.

percent, respectively) with that on commercial and industrial loans (four percent), affected the allocation of funds among different types of loans. Due to the size and complexity of the model, table 3 contains results only for selected variables pertinent to this study, and only year-end balances or total yearly results are included. Monthly and yearly results were calculated for a total of 65 variables (Vergara).

All the results from the basic model are as expected, given the constraints imposed and the relative returns and costs of the various asset and liability variables. They are also

consistent with the profit-maximizing goal of the bank. The results cannot be expected to correspond exactly with the actual balance sheet composition of the rural banks operating under real world conditions; however, the substantive results from the model and their implications are plausible under real world conditions.

A gross profit of P422,220 was obtained from the basic model. Adjusting this for the other operating expenses and other income throughout the 12 programming periods resulted in actual net profit (P) of P213,177 (table 3). This represents the sum of all the

Table 2. The Expected Net Returns on Assets and the Total Costs of Liabilities of the Sample Rural Banks, Central Luzon, the Philippines, November 1979–October 1980

Items ^a	Nominal Return (1)	Service Charge (2)	Administrative Cost ^b (3)	Risk of Default Loss (4)	Net Return ^c (Total Cost) (5)
Percent per annum					
<i>Assets</i>					
SSL	10.71	2.00	1.56	3.32	7.83
LSL	10.71	2.00	.98	2.85	8.88
SOL	10.71	3.00	1.54	2.38	9.79
LOAL	10.71	3.00	.96	2.79	9.96
MLL	12.50	3.00	1.91	4.36	9.23
COML	10.71	3.00	2.47	3.14	8.10
INL	10.71	3.00	1.52	.68	11.51
OL	10.71	3.00	0.00	.94	12.77
CCB	3.0	0.00	0.00	0.00	3.00
XRES	3.0	0.00	0.00	0.00	3.00
ERES	10.32 ^d	0.00	0.00	0.00	10.23
PSR	10.32	0.00	0.00	0.00	10.23
ARC	10.32	0.00	0.00	0.00	10.23
<i>Liabilities</i>					
SD	9.50		1.00		10.50
TD	13.50		.59		14.09
STD	3.00		.25		3.25
BGF	9.50		1.41		10.91
BSF	0.50		.46		9.96
SSDC	0.0		1.27		1.27
REDS	1.0		.35		1.35
REDO	3.0 ^e		.99		3.99
IBRD	9.0		.58		9.58
OBIL	0.0		1.53		1.53
OLIAB	0.0		.20		.20

Source: Vergara

^aSee table 1 for a definition of the variables.

^bOnly direct costs were included in estimating the administrative costs of the balance sheet items in the model. This includes salaries and compensation expense and litigation and asset acquisition expense. These expenses were allocated in proportion to the time spent by bank personnel on each of the classes of assets and liabilities. Depreciation and overhead costs are treated as fixed costs in the model. The latter affect the size of the loan portfolio but not its composition.

^cNet return on asset equals $(1 + 2) - (3 + 4)$ and total cost of liability equals $1 + 3$.

^dThe computed average rate of return on securities is 9.875 percent per annum. Since the return is tax-exempt and the average bank is at a 4.31 percent tax bracket, the before-tax return equals 10.34 percent.

^eThe rediscount interest rate on commercial and industrial papers is four percent per year.

Table 3. Optimal Solution Values of the Structural Variables in the Basic Rural Bank LP Model and Three Alternative Versions, Central Luzon, Philippines, 1980

Variables ^a	Base Model		Version No. 1 A 50% Increase in Loan Demand		Version No. 2 Elimination of Special Time Deposit Seed Fund		Version No. 3 Equalization of Interest Rates on Rediscount Funds	
	Period 12	Total	Period 12	Total	Period 12	Total	Period 12	Total
	----- P 000 -----							
ICCB							217.4	
CCB	807.5		783.4		783.4		1,000.7	
COB		2,398.6						
SSLC	145.5		218.2	3,747.9	145.5	2,197.6	145.5	
SSL	1,919.7		2,694.1		1,900.3		1,919.7	
SOLC	67.4	1,180.7	101.1	1,771.0	67.4	1,180.7	67.4	1,180.7
SOL	1,003.5		1,441.9		1,003.5		1,003.5	
LSLC	196.1	3,436.6	294.2	5,154.9	196.1	3,436.6	196.1	3,436.6
LSL	2,854.2		4,010.5		2,854.2		2,854.2	
LOLC	128.9	2,259.1	193.4	3,388.7	128.9	2,259.1	128.9	2,259.1
LOAL	2,065.1		2,925.7		2,065.1		2,065.1	
MLLC	39.7	476.6	39.7	476.6	39.7	476.6	39.7	476.6
MLL	847.2		847.2		847.2		847.2	
COMLC	81.5	978.6	81.5	978.6	81.5	978.6	81.5	978.6
COML	608.5		608.5		607.1		608.5	
INLC	46.1	553.4	46.1	553.4	46.1	553.4	46.1	553.4
INL	429.9		429.9		429.9		429.9	
OLC	29.5	345.9	29.5	345.9	29.5	345.9	29.5	345.9
OL	242.1		242.1		242.1		242.1	
XRESC	111.9		43.4		69.3			
XRES	111.9		43.4		654.0			
ERES	56.5		56.5		56.5		56.5	
ARC	997.0		1,320.00		994.9		997.0	
SDC	34.4	355.4	34.4	355.4	34.4	355.4	34.4	355.4
SD	2,683.0		2,683.0		2,683.0		2,683.0	
TDC	74.7	512.4	74.7	512.4	74.7	512.4	74.7	512.4
TD	1,226.1		1,226.1		1,226.1		1,226.1	
BGFC	0.7		0.7		0.7		0.7	
BGF	7.5		7.5		8.2		7.5	
BSF	78.8		78.8		78.8		78.8	
SSDC	157.1		235.7		157.1		157.1	
SREDSC		2,352.1		3,527.6		2,052.1		2,143.3
SREDS	1,316.5		1,974.8					
LREDSC		3,240.5		4,860.7		3,240.5		3,118.9
LREDS	2,000.7		3,001.1					
SREDOC		425.7		1,046.6		511.9		
SREDO	135.4		611.1					
LREDOC		612.7		1,488.4		998.2	776.8	
LREDO	57.1		655.1					
CREDOC		167.9		260.9		256.7	260.9	
IREDOC		73.8		119.9		184.4	147.6	
IBRDC	35.3	423.7	35.3	423.7	35.3	423.7	35.3	423.7
IBRD	569.0		569.0		569.0		569.0	
OLIABC	41.9	404.6	42.0		42.0		42.0	404.6
OLIAB	1,025.5		1,025.5		1,025.5		1,025.5	
UI	394.7		546.8		394.7		394.7	
APL	387.4		380.4		286.7		287.4	
P	16.6	213.1	37.3	363.8	15.7	178.6	15.4	157.7
CAP	1,384.9		1,536.1		1,350.4		1,329.5	

Source: Vergara

^aSee table 4 for definition of variables.

period net profits and translates into an optimal return on equity (ROE) to stockholders of 16.68 percent. The average ROE for the 15 rural banks was 22 percent in the previous year.

The model solution values for the liquid asset variables—cash on hand (COH), due from Central Bank (CCB), and due from other banks (COB)—remained relatively constant throughout the year at P783,374. The liquid assets represent exactly 20 percent of the deposit liabilities with required reserves—savings deposits (SD), time deposits (TD), and demand deposits (DD). This percentage exactly matches the recommended primary reserves ratio of 20 percent that was imposed on the model. An optimal total year-end loan portfolio amounting to P9,970,253 was generated by the model (table 3). This represents the sum of the twelfth period solution values of the outstanding loan variables: SSL, SOL, LSL, LOAL, MLL, COML, INL, and OL. Short-term agricultural loans, SSL, SOL, LSL, and LOAL account for 79 percent of the portfolio. Small farm loans, SSL and SOL, constituted 29 percent of the portfolio.

New loans granted, SSLC, SOLC, LSLC, LOLC, MLLC, COMLC, INLC, and OLC, throughout the 12 programming periods summed to P11,729,642. This exceeds the total loan portfolio outstanding at the end of the final period since the latter is already net of matured loans that were repaid. More than 31 percent of the new loans granted are in small farm loans (SSLC and SOLC). For all loan classes, the levels of new loans are at the market limits. As long as the net revenue on loans is higher than the cost of funds, rural banks will maximize their profits by granting loans up to the market limits as long as funds are not limiting. As the results indicate, the availability of funds is not an effective constraint on lending.

The outstanding year-end investment portfolio equalled P1,005,135, inclusive of the investment in preferred stock redemption of P8,110 which was assumed constant during the programming periods. The increase in the investment portfolio originates solely from increases in the investments in Agrarian Reform Credits (ARC).⁴ Starting with an initial level of only P383,711 during the first period, this type of investment rose to

P997,025 at the end of the final period.

An optimal mix of current liabilities heavily concentrated in CB rediscount borrowings (P5,592,628 in rediscounted supervised agricultural loans, SREDSC plus LREDSC, and P1,280,053 in rediscounted ordinary loans, SREDOC plus LREDOC plus CREDOC plus IREDOC) was generated by the basic model. These rediscount funds account for almost 59 percent of the total loans granted throughout the 12 periods. There was a net increase of only P355,358 in savings deposits (SDC) which was almost exactly offset by a decrease in time deposits. New time deposits (TDC) totalled P512,386 but this was exceeded by the maturation of the old time deposits outstanding at the beginning of the first period. Since time deposits are the most expensive source of funds in the model and, except for other liabilities (OLIAB), rediscounting of supervised loans is the least expensive, these results were expected.

These results suggest that rural banks are highly dependent upon CB funds and that they cannot be expected to mobilize funds in rural areas as long as cheaper sources of funds are available from rediscount lines from the CB. However, time deposits could be attractive as a source of funds for investments if the spread between investment returns and time deposits were attractive. Since the spread is negative at current levels, relaxing the interest rate ceilings on agricultural loans would be a logical way to increase the spread and the incentive to mobilize such funds.

The Models

Version 1 (Basic Model): increase in loan demand forecast of 50 percent.

In this version, it is assumed that excess demand may exist only in the case of short-term agricultural loans. Since an exact measure of the excess demand is not possible, the loan demand forecast used in the basic model was parameterized in 10 percent intervals to a maximum of 50 percent

⁴In the Philippines all banking institutions are required to maintain at least 25 percent of the loan portfolio in agricultural loans. At least ten of the 25 percent should be loans to small farmer beneficiaries of the agrarian reform program. The banks are given the option to meet this requirement by purchasing ARC securities from the CB.

above the base loan demand. The optimal solution indicates that the net profit (P) increased to P363,800 with a 50 percent increase in loan demand. The only liabilities that change are the rediscounting variables (table 3). The increases in loan demands have been met solely from increases in rediscounting which is not unexpected since rediscount funds are the lowest cost source of funds and they are not yet at their upper limit. Evidently, without the market restrictions on loan demand, the profit and ROE will increase to an unrealistically high level that will be constrained ultimately only by the available funds. The bank's portfolio specializes in loan types that have the highest net return. This illustrates how the profit contribution of a cheap rediscounting policy is so directly linked to, and constrained by, the demand for loans.

A profit-maximizing bank will arbitrage indefinitely, granting rediscountable loans, rediscounting them, and using the proceeds to make further loans until the limits on rediscount funds are reached. This, of course, assumes that the net return on rediscountable loans is invariant with the volume of loans supplied and that it is higher than the rate of discount. Since the nominal rate of return and the administrative costs are assumed constant, this is equivalent to assuming that the default risk on loans is also invariant with the supply of loans; however, a positive correlation exists between risk and the supply of loans. As the risk increases to the point where the estimated net return on rediscountable loans becomes equal to or less than the rate of discount, the optimal supply of rediscountable loans will be determined. Which of the alternative loan demand forecasts corresponds to this optimum is extremely difficult to determine.

Version 2: suspension of special time deposits (STD) as a "seed fund" to support the supervised credit program of the rural banks. To enable the banks to maximize their participation in the CB-sponsored supervised credit program, the CB has also been providing the rural banks with a seed fund in the form of a three-month STD at an annual interest of three percent. This seed fund is to augment the bank's own liquid funds at the start of the season of the program and thus enable it to accommodate

as many borrowers as possible whose loans can be rediscounted later with the CB to accommodate future borrowers. Quite clearly, the overall profitability of rediscounting to the rural bank is limited by the amount of initial funds it has. In the extreme case where the initial fund is zero, the bank will gain nothing from rediscounting as it will not be able to generate new loans to rediscount later.

The results from a model without the STD as a source of funds show that new loans granted during the first period suffered the most. Considering all the periods, the increase in new time deposits remains the same as in the original model, which suggests that banks do not mobilize new funds to replace STD. Also, the overall effect on the amount of funds allocated to ARC is only P2 thousand less in this model than in the basic model (table 3). Net profit (P) over the periods is P178,600, compared to P213,177 for the basic model. This profit reduction of P31,874 when related to the average monthly STD balance of P262,653 in the basic model implies a 12.14 percent return for the use of STD. And, this represents the maximum return that the banks could offer for funds to replace the STD.

Version 3: equalization of the interest rates on various rediscount funds.

Currently, on supervised agricultural loans, the interest rate on rediscount funds is set at one percent compared to three percent on ordinary agricultural loans and four percent on commercial and industrial loans. The objective of interest rate differentiation is to increase the profitability of supervised agricultural loans relative to other loans and thus induce the rural banks to allocate more of their funds to supervised loans. However, as discussed earlier, as long as the costs of funds needed to finance the various types of loans are less than the net rates of returns on loans, differences in the profitability of loans are irrelevant since availability of funds is not an effective constraint. Only the market constraints effectively limit the allocation of funds among the various types of loans. Further reductions in the costs of funds will have no effect on allocation of funds as long as the market constraints remain effective. Conversely, the costs of funds could be increased without affecting the allocation of

funds among the various types of loans as long as they are below the net return on certain types of loans.

As an empirical test of the above, the basic model was modified by equalizing the interest rates on rediscount funds with the rate on commercial and industrial loans as the basis. As expected, the allocation of funds among the different types of loans remains constant. Among the asset variables, only ARC and CCD were affected. The intertemporal allocation of funds to ARC changed for some periods but the overall amount of funds allocated did not change. There was, however, a reduction in the amount of liquid assets, CCB_t, held by the bank. Among the liability items, only the rediscount funds were affected. There was a decrease in supervised rediscounting—SREDSC_t and LREDSC_t—and an increase in ordinary rediscounting—LREDOCT, SREDOCT, CREDOCT, and IREDOCT. Again this is

consistent with profit-maximizing behavior since as the interest rates are equalized, the "price ratio" moves in favor of ordinary rediscounts. The equalization of discount rates resulted in a profit reduction to P157,700 (table 3). In a counterfactual sense, the profit reduction from the base model to this model represents the amount by which profit would be increased through a policy of preferential rediscount rates for agricultural loans. As evidenced by the results, however, this policy could not be expected to lead to an increase in agricultural loans unless the demand for loans increases.

Conclusions and Implications

The Philippine government, through the Central Bank (CB), initiated the rural banking system and has tried to increase allocation of loans to small farmers through changes in regulatory policy. A multiperiod linear programming model of a representative rural bank is developed to

Table 4. Definition of Selected Structural Variables in the Rural Bank LP Model, Central Luzon, Philippines, 1979-1980

CCB _t :	due from Central Bank in period t
DCCB _t , ICCB _t :	the decrease and the increase, respectively, in CCB
COB _t :	due from other banks in period t
SSLC _t , SSL _t :	(new) supervised small agricultural loans granted and outstanding, respectively
SOLC _t , SOL _t :	(new) small ordinary agricultural loans granted and outstanding, respectively
LSLC _t , LSL _t :	(new) large supervised agricultural loans granted and outstanding, respectively
LOLC _t , LOAL _t :	(new) large ordinary agricultural loans granted and outstanding, respectively
MLLC _t , MLL _t :	(new) medium and long-term agricultural loans granted and outstanding, respectively
COMLC _t , COML _t :	(new) commercial loans granted and outstanding, respectively
INLC _t , INL _t :	(new) industrial loans granted and outstanding, respectively
OLC _t , OL _t :	(new) other loans granted and outstanding, respectively
XRESC _t , XRES _t :	(new) nonreserve eligible securities purchased and outstanding, respectively
ERESC _t , ERES _t :	(new) reserve-eligible securities purchased and outstanding, respectively
ARCC _t , ARC _t :	(new) "agrarian reform credits" securities purchased and outstanding, respectively
SDC _t , SD _t :	(new) savings deposits and savings deposits outstanding, respectively
TDC _t , TD _t :	(new) time deposits and time deposits outstanding, respectively
STDC _t , STD _t :	(new) special time deposits and special time deposits outstanding, respectively
BGFC _t , BGF _t :	decrease in Barrio Guarantee Fund (BGF) and BGF outstanding, respectively
BSFC _t , BSF _t :	increase in Barrio Savings Fund (BSF) and BSF outstanding, respectively
SSDC _t :	special savings deposits outstanding
SREDSC _t :	SSLC _t rediscounted in period t and become available in period t + 1
LREDSC _t :	LSLC _t rediscounted in period t and become available in period t + 1
SREDOCT, LREDOCT, CREDOCT, IREDOCT:	SOLC _t , LOLC _t , COMLC _t and INLC _t rediscounted, respectively, in period t and become available in period t + 1
SREDS _t , LREDS _t , SREDO _t , CREDO _t , IREDO _t :	the end-of-period balances of different types of rediscount borrowings (t=2, ..., 12)
IBRDC _t , IBRD _t :	(new) IBRD and IBRD outstanding, respectively
OLIABC _t , OLIAB _t :	(new) other liabilities and other liabilities outstanding, respectively
UI _t :	unearned interest income for each period
APL _t :	allowance for probable losses for each period
P _t :	net profit/income from loans and investments for each period
CAP _t :	capital accounts outstanding for each period

evaluate the profit-maximizing level of small farm loans given the available alternative assets, and to evaluate the impact of selected regulatory changes on small farm lending and rural bank profitability.

Results from the base model are as expected, given the constraints imposed and the relative returns and costs of the various asset and liability variables. A net profit of P213,177 (16.7 percent return on stockholders equity) was obtained from the base model. An optimal year-end portfolio of P9,970,253 was generated by the model. Short-term agricultural loans account for 79 percent of the portfolio with 29 percent in small farm loans. For all loan classes, the level of new loans is at the market limits. As long as the net revenue on loans is higher than the cost of funds, rural banks will maximize profits by granting loans up to the market limits as long as funds are not limiting. The optimal mix of current liabilities is heavily concentrated (59 percent) in rediscounted agricultural and ordinary loans from the CB. Time and savings deposits are relatively unimportant as a source of funds in the model because they are the most expensive while rediscounted supervised loans are the cheapest. Rural banks are highly dependent upon CB funds and cannot be expected to mobilize deposits in rural areas as long as cheaper rediscount lines are available.

A 50 percent increase in the loan demand forecast increases the net profit of rural banks to P363,800. The increase in loan demand is met solely from increased rediscounting, which is not unexpected since rediscount funds are the lowest cost source of funds. A profit-maximizing bank will arbitrage indefinitely, granting rediscountable loans, rediscounting them and make more loans until the funds are exhausted.

Suspension of the "seed fund" causes a reduction of lending to small farmers and a reduction of banks' profits to P178,600. The results also show that banks do not mobilize new funds from time and savings deposits to replace the loss of STD. Concessional discounting policies from the CB appear to discourage banks from mobilizing local deposits.

Equalizing the interest rates on all loans reduces profits to P157,700 but does not

change the allocation of funds among the various types of loans. As long as the cost of funds is less than the net rate of return on loans, differences in the profitability of loans are irrelevant since availability of funds is not an effective constraint. Only market constraints including risk considerations, effectively limit the allocation of funds among the various types of loans. As evidenced by the results, preferential interest rates increase the profitability of rural bank lending but cannot be expected to increase the flow of funds to small farmers unless their loan demand increases.

This confirms Adams's analysis that rational bankers will merely substitute cheap rediscount funds for more expensive local deposits. A piecemeal policy approach to financial reform will not likely be adequate and may only lead to unintended consequences such as increased bank profits with little or no increase in small farmer credit.

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Effects of Seller Financing on Prices Paid For Farmland

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Abstract

Seller financing of farmland has been hypothesized as contributing to high farmland prices. Net present value models have shown that sellers may find financing the transfer to be more profitable than a cash sale. Results of this study show the per acre price of seller-financed farmland was higher than the price paid for land financed by the Federal Land Bank, Farmers' Home Administration, or commercial banks.

Key words: seller financing, farmland prices, regression model.

In 1945, approximately 49 percent of the farms transferred were credit financed. By 1984, credit-financed transfers had increased to 84 percent (USDA). Sellers represent an important source of credit for farm transfers and accounted for approximately 28 percent of the transfers in 1984 (USDA). The effect of seller financing on farmland prices has been addressed in numerous studies (Barry and Levi; Nixon; and Reinsel). These studies focused primarily on the tax advantages to the seller of seller financing. The trade-off between lower interest rates and higher prices was demonstrated by Reinsel who concluded, "because interest rates are lower for seller financing, such arrangements have raised prices above those that would otherwise exist." Reinsel further pointed out that lowering the interest rate raises the effective demand for farmland. A similar conclusion was reached by Barry and Levi: "sellers may prefer a higher sale price and lower interest rate because of the lower tax obligation on capital gains relative to ordinary income."

Although seller financing frequently is cited as contributing to high farmland prices, there has been little empirical evidence presented to warrant such a conclusion. This conclusion has been drawn mainly from present value models. It is the purpose of this paper to test empirically the hypothesis that prices paid for seller-financed land are higher than prices paid for land financed through other sources.

In the section that follows, the regression model employed to measure the effect of seller financing on land prices is presented. Empirical results are then presented and discussed, with a summary and implications section following.

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Empirical Model

To measure any effect of seller financing on prices paid for farmland, the following model was used:¹

$$Y = \beta_0 + \sum_{j=1}^{16} \beta_j X_j + \epsilon$$

where

- Y = price paid per acre for farmland, adjusted by the consumer price index (1967 = 100),
- X_1 = percent of tract classified as pastureland,
- X_2 = percent of tract classified as cropland,
- X_3 = acres in tract,
- X_4 = dollar value of improvements, adjusted by the consumer price index (1967=100),
- X_5 = rate of interest on the primary note minus the percentage change in consumer prices for the respective year,
- X_6 = percent of purchase price that was financed,
- X_7 = length of term of loan,
- $X_8 \dots X_{11}$ = binary variables representing the degree of urban influence on the tract sold: none, (X_8); slight, (X_9); moderate, (X_{10}); great (X_{11}),
- $X_{12} \dots X_{16}$ = binary variables for lender classes: Farm Credit System (X_{12}), Farmers Home Administration (X_{13}), commercial banks (X_{14}), insurance companies and other (X_{15}), seller (X_{16}),
- ϵ = error term.

Percentage of the tract in pasture and cropland (X_1 and X_2 , respectively) were included as proxies for land quality. Acres not in cropland and pasture were primarily in timber. Acreage in the tract purchased (X_3) was included to test the hypothesis that larger tracts sell for less per acre than smaller tracts, *ceteris paribus*. Since the value of improvements was not the same for all tracts, the effect of improvements on sale price was accounted for by inclusion of the variable X_4 .

The rate of interest charged on the primary note for each sale was adjusted for inflation. Inclusion of an index for inflation as a separate variable was not believed feasible because of problems with multicollinearity between nominal interest rates and the rate of inflation. Therefore, the variable X_5 was expressed as the real rate of interest on the primary note. This real rate of interest was determined by subtracting the rate of inflation (measured by the consumer price index in the year the loan was initiated) from the contractual interest rate. When X_5 is positive, the interest rate exceeds the rate of inflation and the regression coefficient for X_5 would be expected to be negative. Percent of the purchase price borrowed (X_6) was included to test whether lower down payments, generally believed to enhance the marketability of land, affected price. A similar rationale was followed for the inclusion of X_7 , length of term of loan.

The degree of urban influence was included to account for differences in population and demand for farmland for urban conversion throughout the state. It was felt that this approach was superior to including county populations or "dummy" variables for counties. Tracts in areas with "great" urban influence would be expected to sell for more per acre than those in areas with little urban influence.

The primary interest of this study was to test the hypothesis that land prices for seller-financed tracts were higher than prices for tracts financed by conventional sources. This can be quantified by setting up sources of financing as dummy variables. Since the class representing seller financing (X_{16}) was the omitted variable, the prices paid for land financed through other sources could be

¹Data were time series cross-sectional. The model used was a fixed effects model, table 10-1, Model IIa, in Johnston.

compared directly to prices paid for seller-financed land.

The model was fitted to data obtained from the Federal Land Bank of Columbia, South Carolina (FLB hereafter). These data were collected by the FLB for the time period 1971-1981. Data were collected only for bona fide sales. A bona fide sale is defined by the FLB as: "The arms-length transfer of property from an informed seller to an informed buyer, neither of whom is under duress, for a price." Sales were not considered verified until the buyer, seller or both were interviewed. Thus, family transfers and forced sales were not included. Data on 3,067 sales were collected and used in this study.

Results

A backward elimination procedure was used to arrive at a final model. The criteria for eliminating a variable from the initial model were: (a) the variable was not significant at the 95 percent confidence level, and (b) when two or more variables were not significant at the prescribed confidence level, the variable contributing least to the model sum of squares was eliminated first.

Given these criteria, X_7 (term of loan) was the only variable eliminated from the model. Examination of the correlation matrix did not reveal any correlation problem between X_7 and other continuous variables. This is similar to results obtained in a 1975 study by Herr on Iowa and South Dakota farmland prices in which term was found not to be significantly different from zero.

The final model had an R^2 of 0.78 and an overall F statistic (831.30) significant at the 99 percent confidence level. As expected, cropland had a larger effect on tract value than pastureland and price per acre decreased as size of tract increased (table 1). Improvements made a positive contribution to the per acre price, but it was surprising that the coefficient for per acre value of improvements exceeded one. The coefficient of 1.15 differed from both zero and one at the one percent probability level. There are two possible explanations for this coefficient. First, if the buyer divides the purchase price into land and improvements, there is a tendency to overestimate the value of the improvements because improvements

can be depreciated to reduce income tax liability while the land cannot be depreciated. Second, it may be that the value of improvements was understated for loan purposes. Since lenders normally will loan a higher percentage on the value of land than on improvements, buyers can qualify for a larger loan by understating the value of improvements and overstating the value of land.

The overall F statistic for degree of urban influence was significant at the one percent probability level. Signs and relative magnitudes of the coefficients for the dummy variables were consistent with theory. The omitted variable was for great urban influence. Thus, negative signs for the other classes were expected. Land with great urban influence sold for approximately \$376 more per acre than tracts with no urban influence, other factors held constant. As the degree of urban influence increased, the effect on price increased, as was expected.

The financial variables retained in the model were real interest rate, percent of purchase price borrowed, and type of lender. For every one point increase in the interest rate charged, holding the rate of inflation constant, the adjusted sale price per acre declined by \$6.30. The coefficient for percent of purchase price borrowed was negative and significantly different from zero at the one percent probability level. At first glance, this appears inconsistent with theory. It generally is believed that a lower down payment results in a higher sale price. In the Herr study, the coefficient for percent of purchase price financing also was negative for both the South Dakota and Iowa models, and significantly different from zero for the South Dakota model. Herr attributed the negative sign to correlation problems with nonagricultural influences or to "lender's adaptation to risk rather than representing a causal factor determining farmland values." No correlation problems were found for the variables in the study reported here.

Indeed, it may be the case that percent borrowed is not a causal factor, but one that reflects either the credit rating of the borrower or a "good buy." A buyer with a high credit rating would be expected to be able to finance a higher percentage of the purchase price than one with a lower credit

Table 1. Estimated Coefficients and Standard Errors for Variables in the Model

Variable	Estimated Coefficient (standard error)	Variable*	Estimated Coefficient (standard error)
Constant	737.36* (32.03)	X ₈	-376.0* (27.47)
X ₁	190.98* (17.65)	X ₉	-329.0* (28.80)
X ₂	237.71* (13.95)	X ₁₀	-243.0* (29.11)
X ₃	-0.09* (6.01)	X ₁₁	0.0
X ₄	1.15* (0.01)	X ₁₂	-72.01* (13.35)
X ₅	-6.30* (1.61)	X ₁₃	-73.44** (32.15)
X ₆	-0.76* (0.19)	X ₁₄	3.47 (23.05)
X ₇	deleted	X ₁₅	-67.97* (25.63)
		X ₁₆	0.00

*The overall F statistic for X₈, X₉, X₁₀, X₁₁, was 92.20 significant at the one percent probability level. The overall F statistic for variables X₁₂, X₁₃, X₁₄, X₁₅, X₁₆ was 10.33 significant at the one percent probability level. Nonzero coefficients for the dummy variables (X₈ through X₁₆) are for comparison to the omitted variables, zero coefficient, and test of significance is for the respective coefficient to the omitted variable.

*Significant at the one percent probability level.

**Significant at the two percent probability level.

rating. This would enhance the bargaining position of the individual with the higher credit rating. Likewise, lenders loan higher percentages on tracts purchased at less than market value, assuming other factors constant. For tracts that were seller-financed, the mean percentage of purchase price financed was 66.58, while the tracts financed by the Farm Credit System had a mean of 78.24 percent of sale price financed.

The overall F statistic for the dummy variables for type of lender was significant at the one percent probability level. This indicates that prices paid for farmland differ by source of lender. The next step was to compare prices for other lenders to the price for seller-financed land. Results in table 1 show that prices paid for land financed by the Farmers Home Administration, the Farm Credit System, and insurance companies and others were lower than prices paid for land that was seller financed. Prices paid for farmland financed through commercial banks were not significantly different from seller-

financed prices. Further, the differences above were significant at the two percent probability level or higher. It is important to note that these differences are net of the effects of interest rates, percent of purchase financed, land quality, tract size, degree of urban influence, and so forth. That is, holding all other explanatory variables at their means, a tract of land financed through the Farm Credit System would sell for \$72.01 per acre less than one that was seller financed.

The question arises, "What causes the price premium for seller financing?" One reason proffered here is that the difference primarily has been due to risk. That is, the buyer could not obtain a loan from any conventional source and thus had to pay a premium. While this line of reasoning could not be tested empirically, it can be substantiated if one accepts the argument that percent borrowed reflects credit rating since a higher down payment was required under seller financing. Another possible reason is that

interest rates and percent borrowed did not account for other loan features such as balloon payments or interest-only payments for part of the term. Both of these likely would affect the price but were not accounted for because of lack of data.

Summary

A regression model was used to evaluate the effect of seller financing on farmland prices. Other independent variables in the final model were percent of tract in cropland, percent of tract in pasture, acres in tract, dollar value of improvements, real rate of interest paid to finance purchase, percent of purchase price financed, and degree of urban influence. The regression model was fitted to data obtained from the FLB of Columbia, South Carolina, for the years 1971-1981.

Cropland had a larger effect on per acre price than pasture, and the price per acre declined as the size of tract increased. The dollar value of improvements had a coefficient of 1.15. The coefficients for the real rate of interest and the percent of purchase price financed were both negative. As the degree of urban influence increased, the positive effect on per acre price increased.

The primary interest of this study was to test the hypothesis that per acre prices for seller-financed land are higher than sales financed by conventional lenders. The results indicate that prices paid for farmland are affected by source of credit. Prices paid for seller-financed farmland are higher than prices paid for farmland financed by other sources. Since the effect of interest rates, percent of purchase borrowed, and term of loan were accounted for, these higher prices may represent a premium for risk. Since seller financing is involved in a significant portion of land transfers, these higher prices have implications for the farmland market and should be addressed in further research.

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Multiperiod Linear Programming Simulation of Cooperative Loans for Analyzing Equity Capital Programs

Ismail Ahmad, Ken D. Duft, and Ron C. Mittelhammer

Abstract

Increased demand for debt capital, inflation, and the advent of expanded borrower eligibility have prompted Banks for Cooperatives to implement new equity capital programs or adjust the components of pre-existing programs. This paper describes the use of a multiperiod linear programming model for selecting optimum equity capital program components and also describes the means by which the true financing rate can be measured. Results suggest that programs can be structured to the advantage of the borrower while protecting the debt-to-equity positions of cooperative lenders.

Key words: cooperative finance, multiperiod linear program, equity capital optimization, true cost of financing, Banks for Cooperatives.

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This article was prepared as Scientific Paper No. SP 6581, Agricultural Experiment Station, College of Agriculture, Washington State University.

Financial support was provided through Project No. 0502, Agricultural Experiment Station, Washington State University.

The authors are grateful to the anonymous reviewers for their perceptive and constructive comments.

In recent years, a number of Banks for Cooperatives (BCs) have implemented new equity capital programs, while other BCs are currently considering a shift to new capital programs (Cobia). Major factors prompting the BCs to examine their capital programs are: (a) the increase in demand for BC loans from member borrowers (Moore and Fenwick) and (b) the recent entry into the BC system of large new borrowers such as rural electric generating and transmission cooperatives (Duft and A.D. Little). Any shift in equity capital program components impacts the lender's base of support capital and the borrower's true cost of debt.

The objectives of the new equity capital programs implemented by cooperative lenders (BCs) are: (a) to maintain credible equity to loan balance outstanding (Equity:LBO) standards which refer to borrower equity in the BC measured against BC loans made to borrowers; (b) to lessen the disproportionate capital burden on existing member-borrowers (especially when new, large, undercapitalized borrowers enter into the system); and (c) to ensure that ownership of the cooperative lender remains in the hands of those cooperative borrowers currently using BC system services and resources (see Cobia, p. 3). In evaluating new capital programs, the cooperative lender must consider its own viability and also the welfare of its cooperative borrowers since both lender and borrower subscribe to basic cooperative principles. In other words, rather than being profit oriented, cooperative lenders and borrowers should aim to provide services so as to maximize the net worth of member-patrons.

The loan component characteristics (see

table 1) of a BC loan can be complex, and have been shown to have significant financial impacts on cooperative borrowers (Duft). Duft has shown that certain component configurations enhanced the cooperative borrower's position at the expense of the bank, others enhanced the bank's interest at the expense of the borrower, and still others improved the borrower's position while not adversely impacting the bank's position. Therefore, it seemed reasonable that a "mix" of these loan components existed, such that borrower interests would be enhanced, perhaps even optimized, while still remaining in compliance with a bank's specific loan policy constraints, and Equity:LBO standards.

This study develops a multiperiod linear programming model that can be used as a planning tool for analyzing the choices and time paths of the various equity investment programs available in a particular bank-borrower situation. The model is designed to accept, as input, a future interest rate scenario, the rate of return on investment appropriate for a given borrower, and constraints defined by a BC on the time paths of Equity:LBO and loan component usage. The program returns the feasible loan component configuration that maximizes the addition to borrower net worth provided by the loan project. This work also provides the analytic framework for calculating the true financing rate of the BC financing package.

An obvious concern is that a loan component configuration chosen to be optimum from the borrower's perspective might fail to protect the interests of the bank and/or fail to consider the impacts on the lender of variations in equity cash flows over time. However, lender welfare is protected in the programming model via the specification of a set of feasible time paths for loan component implementation and equity capital accumulation.

The model promotes borrower welfare by assuring that among the complicated choices of equity capital programs available for meeting bank-specific equity accumulation targets, the choice is made that meets bank requirements at minimum borrower cost. Equity accumulations requisite to loan volume activity in the BCs are noninterest bearing. Therefore, an opportunity cost to

borrowers is involved whenever it is required of them to invest in such equities. Given the various methods by which borrowers can accumulate equity, an inadvertent choice of equity program, although meeting the time path of minimum equity accumulations required by the bank, may result in the borrower becoming overcapitalized in certain time periods during the loan term, and thus a borrower may be forced to incur unwarranted opportunity cost penalties. The model seeks to minimize or eliminate the overcapitalization problem via the optimum feasible choice of loan component configuration. In particular, the model can be used to identify constraints on loan component choice that inherently lead to overcapitalization, and to analyze borrower costs of requiring the use of various equity accumulation methods.

Overall, this study provides the BC and the cooperative borrower with a mechanism for simulating loan environments and identifying associated constrained optimum equity capital programs that can be used to generate comparative information useful for the actual negotiation of an improved total financing package.

General BC Loan Environment

The BCs employ a variety of equity capital program components to facilitate borrower equity investment in the BC system. Target levels of borrower equity investment (expressed as a percentage of loan balance outstanding) and the time periods allowed for borrowers to reach these targets vary somewhat from bank to bank, but all the BCs strive to maintain the system's minimum standard of a borrower leverage ratio of 12:1 (where the ratio refers to BC total loans outstanding relative to total borrower owned equity in the BC). However, because of seasonal variations inherent in cooperative finance, most BCs attempt to operate at a more conservative ratio of 8:1. The various loan components specified by the BCs to facilitate equity accumulations are described in table 1.

The pattern of net cash flows evolving from within BC term loans is relatively complex compared to those associated with standard

Table 1. Definitions of Loan Components

Override. Cash payments made by the borrower to purchase equity in the BC. The level of override payable in any period is normally expressed as a percentage of the annual interest due on the BC loan, and is paid by the borrower at the time of and in addition to regularly scheduled principal and interest payments.*

Advance capital. A separate loan made to the borrower specifically for equity purchases in the BC. This is normally assessed as a percentage of each loan advance and is repaid in concert with the normal schedule of principal payments.

Patronage retained. Cooperatives return to their member-patrons the annual savings (patronage) that result after deducting operating expenses and other authorized items. A BC may retain a portion (not to exceed 80 percent) of the patronage, if necessary, to maintain or enhance the Equity: LBO levels of its borrowers.

Equity revolve period. This represents the period of time between a borrower's purchase of BC equity and its subsequent cash redemption; commonly referred to as the act of "revolving out."

Reinvestment. The BC may elect to retain a portion of equity that is scheduled to be redeemed if such a practice is deemed necessary to maintain a borrower's Equity:LBO standards. Such equities may be forcibly reinvested for another equity revolve period to retain a borrower's equity at required levels.

*More recently, as interest rates rose dramatically, some BCs elected to assess override as a percentage of a borrower's current LBO. For purposes of this analysis, however, the assessment base is indistinguishable and would affect only the level of assessment, not the manner in which it was analytically simulated.

loans from commercial banks. When a term loan is secured from a commercial bank, typically there is an initial net cash flow in the borrower's favor followed by a series of net cash flows—resulting from interest payment and principal repayments—in favor of the bank during the remaining period of the loan. With BCs loans, however, as a result of the complex features of earned patronage and equity programs, net cash flows may occur in favor of the borrower not only at the beginning of the loan period when loan advances take place, but also at intermittent times during the remaining period of the loan term which can complicate the calculation of the true cost of financing in a BC loan (to be discussed in a

subsequent section). The various cash flows that can take place are illustrated in the prototype BC loan discussed below. Typically, patronage, equity revolve, and reinvestment activities occur only in the fourth quarter of each year. Other cash flows can occur in any quarter of the year.

Multiperiod Linear Programming (MPLP) Model of a Prototype BC Loan

An MPLP model was developed to select an optimal mix of loan components that would maximize additions to borrower net worth, in present value terms, subject to bank borrower specified equity capital constraints, an interest rate scenario, and the borrower's rate of return on invested capital. The objective function to be maximized in the model represents the difference in present values of the cash inflows (flows from bank to borrowers) and cash outflows (flows from borrower to bank). The cash flows are multiplied by a discount factor that represents the borrower's opportunity cost of money, so that the objective function is a measure of the contribution to the borrower's net worth position that would result from the use of the BC loan funds in the borrower's cooperative business. In this study, a 10 percent discount rate was used to reflect the cooperative borrower's opportunity cost of money.¹ This figure is based on a survey of BCs which revealed that a 10 percent return on investment would be a representative figure to apply to cooperative borrowers.

In order to construct the prototype model, a financing package of a specific type, duration, and amount was specified. The BC system provides only three general types of loans (seasonal operating, seasonal

¹There has been some debate in the finance literature regarding the choice of an appropriate discount rate in the objective function of an MPLP model, formulated to solve capital (or financial) budgeting problems. Lockett and Tompkins have stated, "the problem is to determine the relevant discount rate with which to calculate the net present values of the objective function when this same rate is dependent upon the optimal solution." The latter comment was made especially with respect to problems of portfolio selection where capital is rationed over several investment periods. In the MPLP model used here, capital rationing is not assumed, and the problem of project selection does not arise in a single-project problem.

Table 3. Key Equations and Inequalities in MPLP Prototype Model

	Equations or Inequalities	Reference Periods t = quarters, n = years
T1	$CLBO_t = LADV_t + CLBO_{t-1}$	t = 1, 2, ...8
T2	$CLBO_t = CLBO_{t-1} - PRIN_t$	t = 13, 14, ...40
T3	$ADCP_t \leq \$12,500$	t = 1, 2, ...8
T4	$CALB_t = CALB_{t-1} + ADCP_t$	t = 1, 2, ...8
T5	$CALB_8 \leq \$50,000$	t = 1
T6	$CALB_t = CALB_{t-1} - PRAC_t$	t = 13, 14, ...40
T7	$QINT_t = U_t (CLBO_t + CALB_t)$	t = 1, 2, ...40
T8	$OVRD_t \leq 0.2 QINT_t$	t = 1, 2, ...12
T9	$\sum_{t=1}^{12} OVRD_t \leq 0.15 \left(\sum_{t=1}^{12} QINT_t \right)$	t = 1, 2, ...12
T10	$PATR_t = .14 \left(\sum_{i=0}^3 QINT_{t-i} \right)$	t = 4, 8, 12, ...40
T11	$CSPT_t \geq 0.2 PATR_t$	t = 4, 8, 12, ...40
T12	$CSPT_t \leq 0.5 PATR_t$	t = 4, 8, 12, ...40
T13	$PATR_t = CSPT_t + PRET_t$	t = 4, 8, 12, ...40
T14	$8CEQT_t \geq CLBO_t + CALB_t$	t = 12, 13, ...40
T15	$CEQT_t = CEQT_{t-1} + ADCP_t + OVRD_t + PRET_t$	t = 1, 2, ...23
T16	$EQRV_t^n = EQRV_{4(n-5)}^n + EQRV_{4(n-6)}^n + EQRV_{4(n-7)}^n$ $= \sum_{i=0}^3 (ADCP_{4n-i} + OVRD_{4n-i} + PRET_{4n-i} + REIN_{4n-i})$	n = 1, 2, ...10
T17	$EQRV_t = \sum_{i=5}^{(t-4)-i} EQRV_t^{(t-4)-i}$	t = 24, 28, 32, ...68
T18	$EQRV_t = REIN_t + EQPD_t$	t = 24, 28, 32, ...68
T19	$CEQT_t = CEQT_{t-1} - EQRV_t + REIN_t + PRET_t$	t = 24, 25 40
T20	$CEQT_t = CEQT_{t-1} - EQRV_t$	t = 41, 42 68
T21	$CSIN_t = LADV_t + ADCP_t + CSPT_t + EQPD_t$	t = 1, 2, 3, ...68
T22	$CSOT_t = PRIN_t + PRAC_t + U_t (CLBO_t + CALB_t) + ADCP_t + OVRD_t$	t = 1, 2, 3, ...68

commodity, and term) and only term-type loans establish loan balances that extend over a number of years and, thereby, require borrowers to attain and maintain equity capitalization levels beyond a year. Thus, the model was that of a term loan, where a 10-year term was selected and judged to be of sufficient length during which virtually all BCs would require borrowers to attain minimum levels of equity accumulation.

The prototype loan model incorporated specific assumptions concerning certain loan terms such as main loan advance, principal repayment, and interest payment schedules. Due to particular production and/or marketing activities, a given cooperative borrower will generally have a need to seek a set of custom-made loan terms. The model does not preclude the use of irregular advances, balloon payments, interest

deferrals, and the like. In fact, virtually all of the characteristics of a prototype loan can be altered to suit a specific BC/borrower situation. The specific characteristics of the prototype model used here provide the model with a specific structure that can be used as a base from which specific BC situations can be accommodated (see the loan simulation section, where alterations are made to simulate an actual loan package under a current BC system).

An overview of the major constraints placed on the prototype loan project is presented in what follows. There was a total of 483 rows and 967 activities in the MPLP model, and the reader interested in finer detail should consult Ahmad. Referencing table 2 while reading the overview of model constraints will aid the reader in understanding the time flow of the MPLP model. Also, sequential references to equations and inequalities in table 3 will be made in the discussion, a reference T_i referring to the i^{th} equation or inequality of table 3.

Prototype Loan Characteristics

In the prototype MPLP, a \$500,000 term loan was to be repaid within 10 years from the date of first advance. The loan advances were to be disbursed to the borrower in equal quarterly amounts over the first two years of the loan term. (The typical BC loan is used for an investment project that requires a series of such advances rather than a lump sum disbursement). The cumulative loan balance outstanding in any of the first eight periods, $CLBO_i$ is given by the sum of the prior loan balance outstanding, $CLBO_{i-1}$, and loan advances during the period, $LADV_i$ (T_1).

The main loan is amortized over the seven-year period from years four through 10. The amortization schedule for the main loan is externally calculated and based on the quarterly interest rate scenario used in the definition of the loan environment. For the prototype quarterly interest rate scenario, the actual average interest rate cycle experienced by the 12 district BCs during 20 quarters beginning in the third quarter of 1971 and ending in 1976 was used and repeated to construct a 10-year quarterly interest rate scenario (see Ahmad, p. 84). In particular,

the quarterly interest rates used were distinctively cyclic in nature, reaching a trough of 9.93 by quarter 10 and peak of 13.51 by quarter 20. Of course, any rate scenario could have been selected in constructing the prototype model. The rate scenario used has exhibited rate variations that were larger than ever before experienced, and thus provides an example of loan component analysis in a context of volatile interest rate adjustments. Other scenarios can be straightforwardly accommodated. The amount of principal repayment in each quarterly period, $PRIN_i$, is subtracted from the $CLBO$, starting in quarter 13 to establish a sequential decline in the loan balance outstanding until the principal is fully repaid in quarter 40 (T_2).

Advance Capital

Advance capital (ADCP) loans to purchase equity are limited to a maximum of 20 percent of the loan advance, or \$12,500, per quarter (T_3). The cumulative advance capital loan advance (CALB) in a given quarter is equal to the prior balance plus the amount of advance capital loaned in the quarter for quarters one through eight (T_4). The total of advance capital loans during the two years when advance capital loans are made is constrained to be a maximum of 10 percent of the main loan total, or \$50,000 (T_5). The advance capital loan principal is repaid in 28 equal quarterly repayments (PRAC) beginning in quarter 13 (T_6 ; $PRAC_i = CALB_8/28$).

Interest

Quarterly interest (QINT) payments are based on the specified quarterly BC interest rate, U_i , and the total loan balance outstanding by the borrower, including both the amount of the main loan balance plus the advance capital loan balance, $CLBO + CALB$ (T_7). Interest charges cease after quarter 40, when total loan balance principal is repaid.

Override

Override assessments (OVRD) to purchase equity were allowed during the first three years of the financing project. An override charge of up to 20 percent of a quarterly interest payment was allowed in each of the first 12 quarters (T_8). The total amount of override charges during the first three years

was constrained to be a maximum of 15 percent of total interest payments during the period (T9). Override charges cease beginning in the fourth year of the financing project.

Patronage

It is assumed that patronage earned (PATR) is available in the fourth quarter of each year in an amount equal to 14 percent of total yearly interest payments (T10, based on BC survey information). A minimum of 20 percent and a maximum of 50 percent of the patronage earned can be paid to the borrower as cash (CSPT, T11, and T12). The total amount of patronage available in the fourth quarter of a year is distributed between a cash payment to the borrower, CSPT, and patronage retained, PRET, to buy borrower equity (T13).

Equity and Equity Revolve

The minimum borrower Equity:LBO was set equal to .125 which is in the range of current BC system standards. It is assumed that the BCs would allow borrowers up to three years to accumulate borrower equities to the specific minimum borrower equity level. Then, by the twelfth quarter, cumulative equity purchases, CEQT, by the borrower are required to equal or exceed .125 of the total of loan balances outstanding and the ratio of Equity:LBO must equal or exceed .125 through the fortieth quarter of the financing project (T14).

During the first 23 quarters, equities can be accumulated using any feasible combination of advance capital loans, override payments, and retained patronage (T15). Starting in quarter 24 and beyond, maintenance of Equity:LBO standard becomes complicated due to the introduction of equity revolve and reinvestment possibilities. Specifically, equity revolve periods of lengths five, six, or seven years are allowed. For example, equity purchased in year n can be revolved out no sooner than the fourth quarter of the year $n+5$, but must be revolved out by the fourth quarter of year $n+7$ (see equation T16, where $EQRV^n$ represents equity purchased in year n that is revolved out in quarter j). The five to seven year equity revolve period used here encompassed the range of revolve period lengths actually employed by district BCs. While other periods might have been (and

can be) utilized, this range of revolve period lengths included states into which all BCs had converged. Equity revolved in quarter t , $EQRV_t$, can then consist of portions of equity purchased in years $(t/4)-5$, $(t/4)-6$, or $(t/4)-7$ (T17).

The equity revolved in quarter t is distributed between the amount of equity paid back to the borrower, EQPD, and the amount, if any, reinvested to buy equity, REIN, in order to maintain the Equity:LBO standard (T18). Thus, for quarters 24 through 40, the cumulative equity balance of the borrower in any quarter is equal to the cumulative equity account in the previous quarter, minus any equity revolved, plus any reinvestment of equity revolved, and plus any patronage retained (T19; note that since ADCP ceases after quarter eight and override ceased after quarter 12, these variables would have zero values in T19 and are dropped).

After quarter 40, all of the loan principals have been repaid, and thus there is no longer an Equity:LBO standard to maintain. Thus, beyond quarter 41, the current equity account is sequentially depleted by equity revolved, none of which needs to be reinvested (T20).

Cash Flow Summary

Cash inflow (bank to borrower), CSIN, in a quarter is the summation of any main loan advances, advance capital loans, cash patronage payments to the borrower, and equity revolves paid to the borrower during the quarter (T21). The CSIN activity is multiplied by the appropriate positive discount factor for the quarter, and is added to the MPLP objective function.

Cash outflow (borrower to bank), CSOT, in a quarter is the summation of any advance capital loan proceeds (which are used by the borrower to purchase equity and are thus conceptually an outflow as well as an inflow), principal and interest payments on both the main loan and on the advance capital loans, and override payments during the quarter (T22). The CSOT activity is multiplied by the negative value of the appropriate discount factor for the quarter, and is added to the MPLP objective function.

The objective function is, thus, the discounted sum of cash flows produced by

the financing project. The objective function spans 68 quarters in which net cash flows can conceptually occur. The final seven years of the financing project are included solely to accommodate the maximum seven-year equity revolve period, since loan advances and payback are completed within the first 10 years of the project.

Project Appraisal and the Rate of Financing

Regardless of the direction of net cash flows after the initial flow to the borrower, the desirability of the financing project can be appraised using the net present value (NPV) concept (Jean). The appraisal is accomplished in the usual way by dividing each net cash flow in the sequence by a compound rate of return as

$$NPV(r) = \sum_{i=0}^n a_i / (1+r)^i \quad (1)$$

where a_i is a net cash flow in the sequence and r is a specified rate of return. If $NPV(r) > 0$, then at rate of return r the project adds to the net worth of the borrower. In comparing financing projects, the financing project with the higher NPV at rate of return r would be preferable on the basis of additions to the borrower's net worth.

The objective function of the MPLP prototype BC loan is expressed in the form (1). Therefore, if the optimal MPLP solution has chosen a mix of loan components that results in a positive value of the objective function, then the financing project is acceptable to the borrower on the basis of adding to net worth.

The rate of financing compared to the rate of return is another criterion that can be used to appraise financing projects, and the rate of financing itself is important as a measure of the cost of borrowed funds. However, depending on the pattern and level of net cash inflows and outflows, the rate of financing may be functionally dependent on the rate of return, and standard methods for calculating the rate of financing may be inapplicable. In order to examine this problem further, it is useful to categorize a financing project according to whether it is a simple or nonsimple project.

A simple financing project is one in which $a_0 > 0$, and $a_i \leq 0$ for $i=1, \dots, n$; in other words, there is an initial net cash inflow (positive) to the borrower, followed exclusively by net cash outflows (negative) and possibly periods of zero net cash flow. Conventional bank loans are generally simple financing projects. The calculation of the rate of financing associated with financing project $(a_0, a_1, \dots, a_n)$ in the simple project case is done in the usual way by finding the positive discount rate that equates the future value of the sequence of cash flows to zero, as

$$FV(k) = \sum_{i=0}^n a_i (1+k)^{n-i} = 0 \quad (2)$$

A nonsimple financing project is one where cash inflows are not restricted to the initial period. Thus, a nonsimple financing project is one in which $a_0 > 0$, and

$a_i \leq 0$ for $i=1, \dots, n$. Due to the nature of cash patronage and equity revolve, BC term loans are generally nonsimple financing projects. The rate of financing in a nonsimple project can be found by first defining a generalized future value function, $FV_n(r, k)$, by the recursive relationship (Teichroew, et. al.),

$$\begin{aligned} FV_0(r, k) &= a_0, \\ FV_t(r, k) &= \lambda_t FV_{t-1}(r, k) + a_t, \text{ for } t=1, \dots, n, \end{aligned} \quad (3)$$

where

$$\lambda_t = \begin{cases} 1+k & \text{if } FV_{t-1}(r, k) \geq 0 \\ 1+r & \text{if } FV_{t-1}(r, k) < 0 \end{cases}$$

The rationale for the recursive definition of $FV_n(r, k)$ is reasonably straightforward. In the sequence of compoundings that are inherent in defining the future value, a positive balance at a given point in the sequence indicates that capital is still owed to the project, and thus, the balance should be compounded forward using the rate of financing, k , charged on the unpaid balance. However, if a negative balance results at a given point in the compounding sequence, then there exists a net capital investment in the project at that point, and the balance should be compounded at the borrower's rate of return, r , reflecting, in our context, the opportunity cost of having the capital committed to the project and unavailable for use elsewhere.

Setting the future value function defined by (3) to zero and solving for k determines the rate of financing for the project. The solution can take two general forms. It can happen that $FV_n(r,k)=0$ for a value of k for which $FV_t \geq 0$ for every t , in which case $FV_n(r,k)$ is not a function of r at all, and in fact $FV_n(r,k)=FV(k)$. Such a project is called a pure financing project, which roughly speaking, is characterized by the fact that the borrower truly remains a borrower in the sense of being in debt to the project throughout the length of the project. On the other hand, it can be the case that $FV_n(r,k)=0$ iff $k=f(r)$, which can happen only if $FV_t(r,k) < 0$ for some t . Such a project is called a mixed financing project, which

roughly speaking, is characterized by the borrower actually becoming a lender at times during the project in the sense of having a net investment in the financing project.

Regarding project appraisal, if the project is a simple project, or at least a pure financing project, then it can be shown that if $r \geq k$ (or $r < k$), then $NPV(r) \geq 0$ (or $NPV(r) < 0$), and project appraisal on the basis of NPV can proceed accordingly. If the project is a mixed project, then the preceding rule still applies, *except* the rate of financing, k , must be compared to the rate of return, r , on which it is functionally dependent, and not just to any arbitrary rate of return (Teichroew, et. al., p. 173).

Table 4. Current and MPLP Choice Set of Loan Components for BC Y \$500,000, 10-Year Term Loan

Loan Component	Current	Choice Set
Advance Capital (ADCP)	Mandatory Assessment ADCP = 4% of each main loan advance	Quarterly ADCP [0, 10]% of loan advance total ADCP 4% of total loan advances
Override (OVRD)	OVRD = 10% of quarterly interest payments throughout loan term	Quarterly OVRD = 15% of quarterly interest payments, total OVRD = 10% of total interest payments assessment only during first three years
Patronage (PATR)	PATR = 12.5%* of interest paid Retained PATR = 75% of PATR	PATR = 12.5%* of interest paid Retained PATR [50, 80]% of PATR
Equity Revolve	7-year revolve period	5, 6, or 7-year revolve period
Reinvestment (REIN)	Whenever necessary to maintain Equity: LBO standard	Whenever necessary to maintain Equity: LBO standard
Equity: LBO	1:10, to be achieved at point where fixed assessments above accumulate sufficient equity—maintained thereafter. Actual period when 1:10 ratio met for case study loan = year 5, quarter 4**	1:10 to be achieved by year 5, quarter 4**

*While earlier work employed an industry-wide average of 14 percent, BC Ys actual performance of 12.5 percent was used here.

**Choice selected such that even within seasonal variations, this ratio would never exceed the industry self-imposed standard of 1:12.

In general, given an r value, a zero of the future value function (3) will be calculated via a numerical search on k values to identify the rate of financing.

BC Loan Simulation

A variation of the MPLP prototype model was constructed to simulate an actual BC loan environment, and referred to here as BC Y to protect the anonymity of the BC which was involved. The purpose of the BC Y simulation was to provide an illustration of the potential comparative information that the MPLP model can generate concerning borrower cost and loan component configuration differences between an existing BC capital program and a constrained optimum capital program.

The main loan component features of the current BC Y capital program and the MPLP choice set utilized for BC Y are presented in table 4. Loan details of the BC Y MPLP model were identical to the MPLP Prototype BC model discussed earlier except where differences exist in the loan component choice set described in table 4. Except in the case of override, each loan component choice in the current BY Y loan environment was a point in the MPLP choice set. Override assessments were restricted to the first three years of the financing project rather than assessed throughout the loan term, the restricted period of override assessments being more in keeping with current trends in the BC system.²

Highlights of the MPLP results for both the prototype model and the BC Y simulation are presented in table 5. Note that the prototype model utilizes a loan component feasible set that was based on general BC system standards, while the BC Y model utilizes a feasible set that includes the actual loan component configuration employed by the specific BC, so that the feasible sets differ in certain notable respects. Two types of comparative information are available from the results obtained in solving the MPLP

problems. Comparison of the current BC Y loan component configuration with the MPLP configuration illustrates the costs to the borrower of a nonoptional choice of loan components within a feasible set identified by a particular BC. Comparison between the prototype and BC Y MPLP solutions illustrates the relative costs of differing BC loan environments.

In both the prototype BC and BC Y MPLP solution, the NPV of the financing project is positive, the value being \$42,135 and \$49,863, respectively, and thus, either project would add to the net worth of the borrower. Both projects were mixed financing projects, with respective financing rates of 7.715 percent and 7.402 percent, given $r = .10$. Neither of the loan component configurations utilized equity reinvestment as a means of maintaining Equity:LBO standards. Advance capital loans were used to a much greater extent than override assessments to accumulate equity in the first two years when advance capital was available. Equity:LBO standards were maintained exclusively by retained patronage during years four through 10, with a minimum of patronage retained in the majority of quarters.

In comparing the two MPLP \$500,000, 10-year term loans, the borrower would prefer to engage in the financing project offered by BC Y rather than the project of the prototype BC, the NPV being \$7,728 higher in the former case. While the reasons for this outcome are complex and interrelated, the single most important contributing factor was the Equity:LBO requirements of the prototype BC, the ratio being higher (1:8 versus 1:10) and the period for equity accumulation shorter (three years versus five years) than for BC Y. In particular, the prototype BC financing project requires equity purchases of \$68,931 in the first three years while the financing project of BC Y requires only an accumulation of \$31,583. Given the opportunity cost of 10 percent on equity capital, and a minimum revolve period of five years, equity maintenance becomes quite costly in terms of NPV during the early period.

A comparison of the actual BC Y loan component configuration with the configuration specified by the MPLP solution for BC Y reveals an improvement of \$6,939 in

²The effect of not including the current BC Y override assessment choice in the feasible set was to remove a degree of freedom for configuring the loan components. Since this degree of freedom may or may not have been useful in further increasing NPV, the calculated cost savings via MPLP can be viewed as a lower bound.

Table 5. BC Simulation Highlights, \$500,000, 10-Year Term Loan

I. MPLP Prototype BC Loan, NPV=\$42,135, r=.10, k=7.715																
Quarters																
Loan Components ¹	1	2	3	4	5	6	7	8	9	10	11	12	13-16	17-20		
Advance Capital \$			12,500	12,500			12,500	12,500								
(% of Loan Advance)			(20)	(20)			(20)	(20)								
Override \$				1,065			1,484	1,719	1,650	1,581	1,581	1,753				
(% of quarterly interest)				(20)			(20)	(20)	(20)	(20)	(20)	(20)				
Retained Patronage \$				1,100				3,139				3,677	2,888	2,954		
(% of total patronage)				(59)				(80)				(80)	(50)	(50)		
Equity Purchase \$		27,165				31,324				10,242			2,888	2,954		
Equity Revolved \$																
II. MPLP of BC Y, NPV = \$49,863, r = .10, k = 7.402																
Quarters																
	1	2	3	4	5	6	7	8	9	10	11	12	13-16	17-20		
Advance Capital \$			3,098	5,000			5,000	5,000								
(% of Loan Advance)			(6)	(10)			(10)	(10)								
Override \$						1,902										
(% of quarterly interest)						(4)										
Retained Patronage \$								1,219	1,170	1,121	1,121	1,243				
(% of total patronage)								(15)	(15)	(15)	(15)	(15)				
Equity Purchased \$				808				1,797				3,104	3,903	3,958		
(% of total patronage)				(50)				(54)				(80)	(80)	(80)		
Equity Revolved \$		8,096				14,918				7,759			3,903	3,958		
I. MPLP Prototype BC Loan, NPV = \$42,135, r = .10, k = 7.715																
Quarters																
Loan Components	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	53-56	57-60						
Advance Capital \$																
(% of Loan Advance)																
Override \$																
(% of quarterly interest)																
Retained Patronage \$	2,360	1,498	975	738	373											
(% of total patronage)	(50)	(50)	(50)	(50)	(50)											
Equity Purchased \$	2,360	1,498	975	738	373											
Equity Revolved \$	27,165	18,182	11,330	11,748	6,136	2,360	1,498	975	738	373						
II. MPLP of BC Y, NPV = \$49,863, r = .10, k = 7.402																
Quarters																
	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	53-56	57-60						
Advance Capital \$																
(% of Loan Advance)																
Override \$																
(% of quarterly interest)																
Retained Patronage \$	2,000	1,271	829	628	318											
(% of total patronage)	(50)	(50)	(50)	(50)	(50)											
Equity Purchased \$	2,000	1,271	829	628	318											
Equity Revolved \$	8,906	8,637	8,684	9,008	4,209	2,000	1,271	829	628	318						

¹In both loan simulations, no reinvestment in equity appeared in the MPLP solutions.

NPV while still achieving the bank objective of a 1:10 Equity:LBO standard by year five, quarter four. Notable differences in the MPLP solution when compared to current BC Y policy, are: (a) advance capital assessments do not occur in every quarter of the first two years, and when they do occur, generally exceed the level of four percent of loan advances; (b) no override is assessed during the first seven quarters, and then is assessed at maximum levels (which exceed 10 percent of interest payments) during the remaining five quarters of the override period; (c) the majority of equity accumulation is revolved out within five years, and 99.4 percent of accumulated equity was revolved out in six years or less (Ahmad, p. 202); (d) in seven of the 10 years during which patronage was awarded, cash patronage returned to the borrower significantly exceeded the 25 percent level paid to borrowers under current BC Y policy.

Sensitivity of NPV To Individual Loan Component Changes

While the BC Y model employed those loan components actually being used by the selected district bank, one might normally wonder how sensitive NPV computations are to incremental variations in those components used. Certain relationships would seem logical (e.g., increasing advance capital assessments would lower borrower NPV), while others are not so clearly defined (e.g., the impact of a forced reinvestment). Work conducted by Duft, and later by Ahmad, suggest that a shortening of the allowable period of equity revolve tends to lower the borrower's effective interest rate and increase the NPV, as would be expected. However as the length of revolve is reduced to periods shorter than the time allowed by the BCs for full borrower capitalization, the relationship is reversed. The reason for this lies in the fact that continued undercapitalization ultimately triggers the reinvestment provision. In fact, effective rate and NPV were most sensitive to reinvestment, which explains why the MPLP model selected split revolve periods for purposes of avoiding this added borrower cost. As expected, any increase in the allowable Equity:LBO standard (beyond 1:8) reduces required member investment and increases borrower NPV. Similar results could be found as the lending BC reduced

the severity of other loan component constraints. Effective rates and borrower NPV would suggest, therefore, that a negative effect on borrower cost results from acts of leniency granted by the lending BC, but only up to the point where the borrower achieved the goal of full capitalization prior to the time of first equity revolve. When certain minimums are established by the lending BCs, one cannot choose loan components based on such individual sensitivities, but rather, one must rely on the MPLP model to select that composite of individual components which best compliment one another while interacting throughout the term of the loan.

Conclusions and Caveats

Short of running an MPLP for each specific BC-borrower situation, there are a number of general guidelines for loan component choice that have been suggested by the simulations in this study. First, an aggressive equity accumulation policy characterized by a high Equity:LBO standard, and a short period in which to achieve the standard, is quite costly to BC borrowers. If a BC cannot consider lowering its Equity:LBO standard, then lengthening the equity accumulation period would be beneficial.

Although total advance capital and total override assessments may be constrained by maximum BC-acceptable levels over the whole term of the loan, it is beneficial to allow cooperative borrowers some flexibility in negotiating the level of the assessments in each quarter. As indicated in the MPLP results, it can be advantageous for the borrower to be assessed greater amounts of advance capital and override in some quarters than others.

The MPLP results further suggest that BCs should consider paying a higher proportion of earned patronage in cash. The legal minimum (IRS Section 521) 20 percent cash patronage levels can be paid in the years prior to the time when borrower's Equity:LBO ratio is lower than the minimum level specified by the BC. Once the desired Equity:LBO ratio is attained, the cash portion of patronage could be increased (a level of up to a maximum of 50 percent was found advantageous in this study). In this regard, the authors acknowledge that while operating under Section 521, the proportionate payment

of patronage in cash must be uniformly applied to all member borrowers. Despite this restriction, the results would suggest that even when viewing the entire loan portfolio as a single entity, the BC and their borrowers may benefit from year-by-year variations in the proportionate cash payment. Finally, it should be recognized that data now suggest that more cooperatives are relinquishing their tax status and drifting away from 521 constraints (Wissman, p. 18).

Reinvestment should be minimized or, if possible, eliminated entirely. Equity reinvestments are costly to members because reinvestments require that some equity be retained in the BC for another period of time that is at least equal to the BCs current equity revolve period length. Also, the MPLP analyses suggest that BCs should adopt shorter revolve period lengths (such as the five-year length) in preference to the long revolve period lengths currently employed by some BCs. However, there may be periods when the equity revolved amounts cannot be all paid in cash; paying the full amount of equity revolve may adversely impact borrower Equity:LBO levels. For such periods, a combination of revolve period lengths would appear to be beneficial. This means that the total amount of equity purchases in a particular year can be split into two or more sums that can be revolved to the borrower using different length revolve periods. The shortest revolve period can be used for equity revolves whenever it is possible to pay all of the revolve sum as cash. The advantage of splitting revolve cycles is that combination of revolve periods can be used to prevent an expensive equity reinvestment that must be committed for another full equity revolve period.

As a final note, the complexity of net cash flow patterns render the BC loan a mixed financing project, and as a result, the so-called contract rate of interest associated with the loan agreement becomes a rather inaccurate measure of the actual cost of financing. Even so-called effective interest rates estimated by the cooperative lenders fail to recognize the borrower's employment of capital during those intermittent periods of net cash inflows which may accompany the loan. Our approach provides a means for accurately assessing the true rate of financing, even under those circumstances where lender-borrower loan conditions allow

for variations in net cash inflows and outflows over the loan term.

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The Effects of Equity Position, Credit Policy, and Capital Gains on Farm Survival

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Abstract

The RICESIM model was used to evaluate the impact of beginning equity, minimum required equity, and land capital gain rates on survival of a representative Upper Gulf Coast Texas rice and soybean farm for the period of 1984-1988. Credit policy was important to farmers at intermediate beginning equity positions. Credit policies that allowed leverage ratios in excess of 2.0 increased producers' probability of survival but also significantly increased the potential for lenders to incur large losses.

Key words: credit policy, capital gains, survival, simulation

Financial conditions for farm operators and farm lenders have deteriorated markedly since 1980. The farm economy has experienced a prolonged period of steady domestic and falling foreign demand which, when coupled with continued overproduction of farm commodities, has resulted in persistent downward pressure on farm incomes and, consequently, net worths of farmers. Many moderately and highly-leveraged farm operators face severe cash flow problems, declining asset values, and a decreased ability to meet debt obligations (USDA-ERS).

The current financial dilemma can be traced to events of the 1970s. During that period, expanding export markets caused large annual increases in demand for agricultural products. High farm prices encouraged expansion of farming operations. Low real interest rates encouraged use of debt in financing farm expansions. Many farmers converted their short-term assets into assets of a more long-term nature, such as equipment and land (Boehlje and Eidman). When conditions reversed in the 1980s, many farmers who had expanded their operations using debt capital suddenly found they could not service their higher debt load.

During the 1970s, aggressive credit policies were practiced by many farm lenders. More conservative lending policies have been adopted in the last few years, however, as a result of increased loan delinquencies and increased farm bankruptcies (*Agri Finance*). When forced out of business as a result of tighter credit, farm operators frequently label the financial community as "too conservative" or unwilling to help the operator in time of need. It is often unclear, however, if the decision to not extend further

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Technical Article No. 19818 of the Texas Agricultural Experiment Station.

credit prematurely forced the farm operator out of business or saved him or her from losing additional equity.

Critical factors contributing to current and future farm financial problems are the current debt level, declining asset values (particularly land), insufficient cash flow, and maintenance of credit and credit worthiness (USDA-ERS). In this study, the interrelationship of current debt, capital gains on land, and credit policy are examined in detail.

Several studies have been conducted addressing the effects of initial equity position, credit policy, and capital gain rate for land (Patrick; Helmers and Held; Musser, White, and Smith; Skees and Reid; Skees, Reed, and Pederson). Yet, when evaluating the relative importance of these three variables on farm survival, all are limited by one or more factors. Only two or three beginning equity ratios and credit policies (i.e., required minimum equity levels) were examined in each study. The equity ratios and credit policies examined do not represent the wide spectrum of possibilities for these variables. More important, no attempt was made to examine the inter-relatedness of beginning equity, credit policy, and land values on farm survival. For example, do credit policies affect all farm operators in the same manner, or are some producers more vulnerable to negative effects from credit policy than others? Most of the studies examined full-owner and part-owner farm situations, even though tenant operations have been judged most vulnerable to insolvency under the current farm policy (Grant, Richardson, Brorsen, and Rister). In addition, some behavioral assumptions were made about the representative farm operator that are not realistic for the current farming situation. For example, farm growth was allowed in all but the Skees and Reid study and was implicitly encouraged in some studies through favorable assumptions. Whereas growth was of some importance to farmers in the 1970s, it is currently of low priority to many farmers, especially those struggling to survive.

In addition, an examination of beginning equity, credit policy, and land value effects on farm survival also provides valuable insights to policy makers. Several proposals

have recently been suggested for dealing with the current debt crisis in agriculture (Harl; Riley). Before adopting a particular bailout plan, it is critical to identify the types of farming operations with the greatest need for assistance and the level of assistance needed. Programs can then be targeted toward those farm operators who can benefit most from assistance, thereby avoiding additional program costs for those that do not need assistance and those for whom assistance is of little or no value.

The purpose of this study is to examine the effects of different beginning equities, credit policies, and capital gain rates for land on survivability and ending equity of a representative Texas rice and soybean farm. Emphasis is made on the influence of external credit rationing, in the form of changes in lenders' credit policy, on farm survival. Results for a fully-leased farm are contrasted with those for a partly-owned, partly-leased farm.

Simulation Model and Representative Farm

The RICESIM model was used in the analysis. RICESIM is an updated and expanded version of FLIPSIM V (Richardson and Nixon) that has been altered to explicitly account for the marketing and policy situation facing Texas rice farmers. Because studies using FLIPSIM have been published elsewhere in this journal (Nixon and Richardson) and in other journals (Condra and Richardson; Richardson, Lemieux, and Nixon), no detailed explanation of the model is given here. Briefly, RICESIM is a firm level, Monte Carlo simulation model that simulates annual production, farm policy, marketing, management, and income tax aspects of a farm over a chosen planning horizon. The model recursively simulates the farming operation by using the current year's ending financial position as a beginning financial position for the next year. Pseudo-random prices and yields simulate the actual stochastic nature of these variables.

Probability of survival is the probability the farm operator will maintain the farm's intermediate and long-term leverage (equity) ratios at less (greater) than the maximum (minimum) credit policy leverage (equity)

ratio levels established by local financial institutions. The farm operator must have a positive cash balance at the end of each production year. In the model, the farm operator is forced to liquidate his farm assets if a negative cash balance exists at the end of a production year and refinancing to cover the negative balance would result in intermediate and long-term leverage (equity) ratios being above (below) the maximum (minimum) permitted level.

A representative, high level management, Upper Gulf Coast farm was analyzed in the study.¹ The farm, located in Liberty County, Texas, consisted of 2,300 acres of farmland (95 percent of which was tillable) and a 10-acre farmstead. Only eight percent of the 1982 Liberty County farms were larger than 1,000 acres, but these few farms represented almost 73 percent of the harvested acreage. More importantly, 38 percent of the farms having irrigated acreage in the county were larger than 2,000 acres. The average size of Liberty County farms with more than 2,000 acres was almost 2,600 acres. Based on these facts, the representative farm is larger than the average Liberty County farm, but is quite representative of the farms controlling most of the acreage in the county.

The wholly-leased tenant farm operator leased all farm acreage, but owned or was purchasing the land and buildings on the 10-acre farmstead. The part-owner farm operator was leasing 1,150 acres of the farm and owned or was purchasing the remaining 1,160 acres. Leased land was farmed on shares, the most common rental arrangement in the area (Griffin, Perry, and McCauley). A soybean-soybean-rice crop rotation was assumed, as it is the predominant rotation used in the Upper Gulf Coast area (Boldt and Kennedy). In 1982, these crops constituted over 93 percent of the total crop acreage in the county (U.S. Department of Commerce).

The simulation period for RICESIM was 1984–1988, with 50 iterations of the model performed for each scenario. Prices and yields were randomly generated using multivariate empirical distributions. Empirical yield distributions were subjectively

estimated by farmers and agricultural experts in the study region. Empirical price distributions for soybeans were based on behavior of soybean prices during the 1973–1982 period. An econometric simulation model developed by Grant, Beach, and Lin was utilized to predict rice prices between 1973–1983. The differences between predicted and actual prices were used to develop the rice price distributions. County level price and yield data from the study area were used to estimate the price and yield correlation matrix.²

Participation in current farm programs for rice and soybeans was assumed. Target prices and loan rates for 1984 and 1985 were set at the values specified in the 1981 farm bill. Values for these variables in 1986–1988 were set at their respective 1985 levels.

Financial Assumptions

The 10-acre farmstead consisted of three buildings with a market value of \$155,000 and land valued at \$1,200 per acre. The crop land being purchased by the part-owner was also assumed to have an initial market value of \$1,200 per acre. Intermediate-term assets were the same for both tenant and part-owner. The beginning market value of all farm machinery was \$565,200. Intermediate debt was incurred only through equipment purchases. Both tenant and part-owner also had \$20,000 in off-farm investments. The total beginning market value for tenant farm assets was \$737,200. The overall market value of the part-owner farm was \$2,117,200.

Eight different types of interest rates were used in the model. Annual values for these interest rates were set for each year in the five-year simulation period. The various interest and inflation rates used are in table 1. The interest rate on long-term loans obtained previous to the study period was 11.75 percent, with the interest rate on old intermediate-term loans set at 15 percent. New long-term, intermediate-term, and operating loan rates were calculated for the period 1984–1987 using the COMGEM econometric model (Penson, Hughes, and Romain). These rates ranged from 10.5 percent to 13.1 percent for long-term loans,

¹It was assumed the operator had a proven record of good management ability and integrity, so credit issues relating to the person were ignored.

²More information on the price yield distributions can be found in a study by Perry, et. al.

Table 1. Projected Interest and Inflation Rates 1984-1988

	1984	1985	1986	1987	1988
Annual Interest Rates:					
	Percent				
Pre-1984 L.T. Loans	11.7	11.7	11.7	11.7	11.7
Pre-1984 I.T. Loans	15.0	15.0	15.0	15.0	15.0
New Long-Term Loans	13.1	11.7	10.9	10.5	10.5
New Int.-Term Loans	14.8	14.9	14.1	13.7	13.7
Refinance L.T. Loans	13.1	11.7	10.9	10.5	10.5
Refinance I.T. Loans	14.8	14.9	14.1	13.7	13.7
Operating Loans	15.2	15.4	15.6	14.2	14.2
Return on Savings	11.8	11.9	11.1	10.7	10.7
Annual Inflation Rates:					
Used Machinery	0.0	0.0	0.0	1.0	1.0
Off-Farm Investments	11.8	11.9	11.1	10.7	10.7
All Other Costs	5.4 ^a	4.7	4.5	4.8	5.0
On-Farm Buildings	-2.0	-2.0	-2.0	-2.0	-2.0

Source: Penson.

^aInitial prices used in the model for new farm machinery and off-farm storage costs are for 1984. Therefore inflation rates for these costs were equal to zero in 1984.

13.7 percent to 14.9 percent for intermediate-term loans, and 14.2 percent to 15.6 percent for operating loans. For 1988, interest rates were held constant at 1987 levels.

Annual inflation rates for 14 different production costs and returns on investment were also specified in the model. In most cases, the general inflation rate predicted by COMGEM for farm inputs was used to inflate production costs. The annual rates used were: 5.4 percent in 1984, 4.7 percent in 1985, 4.5 percent in 1986, 4.8 percent in 1987, and 5.0 percent in 1988. Inflation rates for used equipment were zero percent for 1984-1986 and one percent in 1987-1988. The 1987-1988 rates reflected the expectation that used equipment will become more scarce and, thus, more valuable during the latter part of the 1980s.

Although Skees and Reid have argued land values were closely linked to farm income, others (Castle and Hoch) have maintained that additional factors may also significantly influence land values. Indeed, Pope and Goodwin found that agricultural productivity was the fifth most important characteristic considered by purchasers of rural land in Texas. Proximity of the representative farm to the Houston metropolitan area likewise causes land values to be relatively immune to farm income variation (Gilliland). For these reasons, a constant increase in land values of seven

percent per year was assumed for the base analysis, seven percent being the approximate increase in area land value during 1982-1983.

In many areas throughout the country, farmland has dropped in value as a result of the recent recession. To broaden the applicability of the results beyond the Upper Gulf Coast area, a second capital gain rate of minus three percent per year was also examined.³ This capital gain rate is in line with declines in farmland value experienced in the South during 1981-1984 (USDA-ERS). In both scenarios, capital gain rates for used equipment were zero percent per year through 1987 and one percent in 1988, with farm buildings depreciating in value two percent per year. Although market values for equipment and building may also be linked to farm income, holding their values constant across all scenarios permits examination of land capital gain rates and their effects on farm survival.

Discussion with bankers in the Liberty County area indicates a typical farm has long-

³This assumes farmland values are not a function of farm income and interest rates may be inaccurate for many areas in the U.S. This assumption may limit the applicability of the results to those areas of the country. The study, nevertheless, provides some insight into the effects of land capital gain rates on survival in those areas.

Table 2. Financial Positions for a Representative Tenant Rice and Soybean Farm Located in Liberty County, Texas

	Initial Farm Equity Positions					
	.25	.40	.60	.75	.90	1.0
Total On-Farm Assets:						
Intermediate (\$)	570,200	570,200	570,200	570,200	570,200	570,200
Long-Term (\$)	167,000	167,000	167,000	167,000	167,000	167,000
Intermediate-Term Debt:						
Debt (\$)	421,948	332,937	226,081	134,536	53,848	0
Leverage Ratio	2.85	1.40	.67	.31	.10	.00
Equity Ratio	.26	.42	.60	.76	.91	1.00
Long-Term Debt:						
Debt (\$)	130,928	109,385	66,800	49,766	19,873	0
Leverage Ratio	3.63	1.90	.67	.42	.14	.00
Equity Ratio	.22	.35	.60	.70	.88	1.00
Overall Debt:						
Debt (\$)	552,876	442,322	292,881	184,302	73,721	0
Leverage Ratio	3.00	1.50	.67	.33	.11	.00
Equity Ratio	.25	.40	.60	.75	.90	1.00

Table 3. Financial Positions for a Representative Part-Owner Rice and Soybean Farm Located in Liberty County, Texas

	Initial Farm Equity Positions					
	.25	.40	.60	.75	.90	1.0
Total On-Farm Assets:						
Intermediate (\$)	570,200	570,200	570,200	570,200	570,200	570,200
Long-Term (\$)	1,547,000	1,547,000	1,547,000	1,547,000	1,547,000	1,547,000
Intermediate-Term Debt:						
Debt (\$)	421,948	332,937	226,081	134,536	53,848	0
Leverage Ratio	2.85	1.40	.67	.31	.10	.00
Equity Ratio	.26	.42	.60	.76	.91	1.00
Long-Term Debt:						
Debt (\$)	1,166,438	937,482	528,455	394,485	157,794	0
Leverage Ratio	3.06	1.54	.67	.34	.11	.00
Equity Ratio	.246	.394	.60	.745	.898	1.00
Overall Debt:						
Debt (\$)	1,588,386	1,270,419	754,536	529,021	211,642	0
Leverage Ratio	3.00	1.50	.67	.33	.11	.00
Equity Ratio	.25	.40	.60	.75	.90	1.00

and intermediate-term equity to asset ratios of .60. This level of equity (60 percent) was used as the base beginning equity level for both tenant and part-owner. In addition, five other beginning equity levels, ranging from 25 percent to 100 percent, were identified for analysis. These five financial positions were chosen to represent the range of equity positions in the study area. Detailed

descriptions of each beginning equity position examined for tenant and part-owner, respectively, are indicated in tables 2 and 3.

As noted before, RICESIM liquidates the farming operation when a negative cash flow exists and the farm has been leveraged to the maximum level allowed by the financial institution. In other words, the institution

approves loan refinancing for the farm strictly on the basis of financial ratios, ignoring all other considerations. In reality, bankers evaluate several factors before approving or denying a loan request. Some factors considered by the Federal Intermediate Credit Bank and PCAs of Texas include: (a) the person requesting the loan, (b) purpose of the loan, (c) repayment capacity, (d) collateral taken as security, and (e) financial position and progress (Federal Intermediate Credit Bank of Houston). A study by Dunn and Frey found, nevertheless, the liability to asset ratio (equity ratio times leverage ratio) was "by far the most important . . . (characteristic used by loan officers) in determining whether a loan would become acceptable or a problem" (p. 65).

Bankers in Liberty County indicated it is not their policy to extend further credit to a farm operation with a leverage ratio above 2.0 (i.e., a minimum equity ratio of .33). This leverage ratio was used as the base level in the study. In addition, five credit policy leverage ratios were identified to examine the impact of both tighter and less restrictive levels of credit on farm survival and economic success. The five additional leverage ratios (minimum equity positions) were 1.0 (.50), 1.5 (.40), 2.5 (.286), 3.0 (.25), and 4.0 (.20). For each credit policy, the same required leverage (equity) ratio was used for both long-term and intermediate-term debt. Part-owner operations were not allowed to sell land to avoid farm liquidation.

Results and Analysis

Probabilities of survival for the tenant and part-owner situations at each beginning equity position and credit policy, assuming a capital gain rate of seven percent per year for land, are presented in table 4. Probabilities of survival exceeded ninety percent when beginning equity ratios were above .90 for the tenant and above .75 for the part-owner. The tenant's probability of survival was above 80 percent when beginning equity ratios were .60 and above and minimum required equity was less than 25 percent. Similarly, survival was above 80 percent for the part-owner when beginning equity ratios were .40 and above. At a beginning equity ratio of .25, both tenant and part-owner had less than a 25 percent chance of surviving through 1988. In comparing the tenant and part-owner results when the capital gain rate for land is seven percent, the part-owner is as well off as, or better off than the tenant when both have the same beginning equity positions.

Credit policy had little impact on survival when equity ratios were .75 or more for the tenant, or were .60 or more for the part-owner. Credit policy also had little effect on survival of the tenant or part-owner at low beginning equity levels, (i.e., .25 equity ratios) with farm liquidation occurring over 80 percent of the time under even the most liberal credit policy. Only at intermediate equity levels (.40 to .70 equity ratios) did credit policy play a significant role in farm survival. At 60 percent beginning equity for

Table 4. Probabilities of Survival^a for a Representative Texas Rice and Soybean Farm with Different Beginning Equity Positions and Credit Policies — Capital Gain Rate of Seven Percent for Land

Credit Policy Leverage (Equity) Ratio ^b	Initial Farm Equity Positions											
	----- Tenant -----						----- Part-Owner -----					
	.25	.40	.60	.75	.90	1.0	.25	.40	.60	.75	.90	1.0
1.0 (.5)	0	0	26	78	96	100	0	0	74	100	100	100
1.5 (.40)	0	2	58	92	100	100	0	2	100	100	100	100
2.0 (.33)	0	20	82	96	100	100	0	38	100	100	100	100
2.5 (.28)	0	36	86	98	100	100	0	70	100	100	100	100
3.0 (.25)	6	40	88	98	100	100	2	82	100	100	100	100
4.0 (.20)	18	54	92	98	100	100	14	92	100	100	100	100

^aProbability of survival is the probability that the farm operator will maintain the farm's intermediate and long-term leverage ratios at less than maximum levels established by local financial institutions. Probability of survival is expressed as a percent.

^bMaximum (minimum) permitted leverage (equity) ratios.

Table 5. Probabilities of Survival^a for a Representative Texas Rice and Soybean Farm with Different Beginning Equity Positions and Credit Policies — Capital Gain Rate of Minus Three Percent for Land

Credit Policy Leverage (Equity) Ratio ^b	Initial Farm Equity Positions											
	-----Tenant-----						-----Part-Owner-----					
	.25	.40	.60	.75	.90	1.0	.25	.40	.60	.75	.90	1.0
1.0 (.50)	0	0	26	78	96	100	0	0	22	96	100	100
1.5 (.40)	0	2	58	92	100	100	0	0	68	100	100	100
2.0 (.33)	0	16	82	96	100	100	0	4	88	100	100	100
2.5 (.28)	0	34	84	98	100	100	0	6	92	100	100	100
3.0 (.25)	6	40	88	98	100	100	0	10	96	100	100	100
4.0 (.20)	18	52	92	98	100	100	0	24	98	100	100	100

^aProbability of survival is the probability that the farm operator will maintain the farm's intermediate and long-term leverage ratios at less than maximum levels established by local financial institutions. Probability of survival is expressed as a percent.

^bMaximum (minimum) permitted leverage (equity) ratios.

the tenant, for example, a fourfold increase in the maximum permitted leverage ratio (from 1.0 to 4.0) caused probability of survival to increase from 26 percent to 92 percent. Results for the part-owner at a beginning equity ratio of .40 were even more dramatic, with survivability increasing from zero percent to 92 percent with change of the required leverage ratio from 1.0 to 4.0.

Results for a minus three percent per year capital gains rate for land are reported in table 5. The results for the tenant situation were virtually the same under both capital gain rates, a result that was not surprising since land represented less than two percent of the tenant farmer's assets. Results for the part-owner were also the same under the seven percent and minus three percent capital gain rate when beginning equity was 75 percent or more. When beginning equity was 60 percent or less, the negative capital gain rate had a significant impact on the part-owner operation. Probability of survival was less than 25 percent for the part-owner when beginning equity was 40 percent or less.

Credit policy became much more important to the part-owner at a .60 beginning equity ratio and less important at a .40 ratio. The tenant operator was only slightly worse off than the part-owner when both had .75 and .60 equity ratios and was much better off at beginning equity ratios of .25 and .40. The results suggest, for the capital gain levels tested here, only part-owners in intermediate and high debt positions are threatened by

depreciation in land value. In addition, the part-owner faced with an expected negative capital gain rate on land and a high debt position may well improve his or her chances of survival by selling land and continuing to farm as a tenant. These conclusions for the part-owner are even more applicable to a full-owner operation.

Effect of Relaxing Credit Policy

From the survivability results presented thus far, it appears both tenant and part-owner farmers in the intermediate debt range (i.e., 0.40 to 0.60 equity ratios) are particularly sensitive to credit policy. If the lender relaxes credit policy, the farmer has a much greater chance of still being in operation at the end of 1988. The survivability statistics do not, however, provide an indication as to the financial well-being of the farmer at the end of the five-year period at different credit policy levels. The surviving farm operator could be either on the brink of bankruptcy in 1988 or free of any debt.

Nor do the survivability results provide any insight into whether tighter credit policies tend to prematurely force operations into insolvency. We define a prematurely insolvent operation as one that would be forced out of business at an initial credit policy but, when given additional credit, is able to recover from its precarious financial position. In the context of this study, farms forced out prematurely are those whose leverage ratios rise above the cutoff level for credit in one year (thereby causing farm liquidation), but survive under a more liberal

credit policy and finish the five-year period with a lower leverage ratio than that at which they were previously forced out of business.

Ending equity ratios for the scenarios sensitive to credit policy are summarized in table 6 for a credit policy with a maximum leverage ratio of 4.0. The 4.0 leverage ratio was used because it was the least restrictive, allowing large losses in equity before forcing the operator out of business.⁴ At a beginning equity ratio of .40, neither tenant nor part-owner operations were very successful in the long term. The part-owner operation appeared to maintain its initial financial position when the capital gain rate for land was seven percent per year, with a 58 percent chance that ending equity ratio will be within the .33 to .50 range. At a minus three percent capital gain rate, however, the part-owner had almost no chance of improving on the 40 percent beginning equity position, but faced a high probability (76 percent) of losing more than half of the initial equity. The tenant's ending equity ratios were much more volatile than the part-owner's, with a 38 percent chance of an ending equity ratio in excess of .50 and a 48 percent chance of an ending ratio less than .20. As with survivability, changes in capital gains had almost no effect on ending equity ratio for the tenant.

Results were much more favorable at a beginning equity ratio of .60. Chances of ending equity ratio being greater than .50 exceeded 60 percent for both tenant and part-owner and were as high as 86 percent for the part-owner when capital gain rate for land was seven percent per year. The part-owner farm operator with a .60 beginning equity ratio appeared to have a good chance of improving his or her equity position (or of at least maintaining it when capital gain rates for land were negative) providing credit policies are sufficiently liberal to allow the operator a chance to recover from a bad year.

The harshness of the 1.0 leverage ratio credit policy when beginning equity was 60 percent

is borne out in examining the iterations forced into insolvency at that credit level. At a seven percent capital gain rate for land, 37 iterations were forced out in the tenant scenario (i.e., a probability of survival equal to 26 percent). Of these 37 iterations, 64 percent ended the study period below the 1.0 leverage ratio threshold.⁵ Even when capital gains were minus three percent, 51 percent of the part-owner iterations forced into insolvency at the 1.0 leverage ratio finished the period with leverage ratios below 1.0 when the more liberal policy was enacted. These results suggest a 1.0 credit policy has a good chance of prematurely terminating a farm operation that would probably recover if given additional credit.

When beginning equity is 40 percent, tight credit policy appears more appropriate. As mentioned before, the part-owner has little hope of increasing equity in his or her farming operation, but stands a good chance of losing remaining equity. From these results, it appears that optimal credit policy is inversely related to beginning equity position, tightening as equity falls and being loosened as equity is increased.

A leverage ratio of 2.0 performed much better as a credit policy. When beginning equity was 40 percent and the capital gain rate was seven percent, the tenant was prematurely forced into insolvency in 38 percent of the iterations at a 2.0 credit policy leverage ratio. For the same beginning equity and capital gain rate levels, the 2.0 credit policy prematurely forced the part-owner out of business 42 percent of the time. By contrast, when the capital gain rate was minus three percent, the 2.0 credit policy forced the part-owner into premature insolvency in only two percent of all iterations. These results suggest optimal policy is also inversely related to capital gain rates for land.

Another method of illustrating the impact of different credit policies is reporting total debt

⁴Results for other credit policies were not reported because they would be much the same as those reported for the 4.0 leverage ratio. The major difference would be that the tighter policies would prevent equity levels from falling below 20 percent, since credit would be cut off sooner.

⁵The 64 percent figure was calculated as follows: for the tenant with a .60 beginning equity ratio and seven percent capital gain rate, 36 iterations (72 percent in table 6) ended the five-year period with leverage ratios less than 1.0. Of these, 13 survived when the credit policy leverage ratio was 1.0. The remaining 23 iterations rose above 1.0 sometime during the five-year period, but were below the 1.0 leverage ratio in 1988. Therefore, 23 of 36 iterations (64 percent) were prematurely declared insolvent.

Table 6. Probability of Ending Equity Ratios^a Falling Between Indicated Intervals for Selected Beginning Equity Positions When Required Leverage Ratio Is 4.0

Ending Equity Ratio Intervals	.40 Beginning Equity Ratio				.60 Beginning Equity Ratio			
	-3% Capital Gains		7% Capital Gains		-3% Capital Gains		7% Capital Gains	
	Tenant	Part-Owner	Tenant	Part-Owner	Tenant	Part-Owner	Tenant	Part-Owner
Above .50	38	0	38	6	72	62	72	86
Below .50 and Above .33	10	6	12	58	16	30	16	14
Below .33 and Above .20	4	18	4	22	4	6	4	0
Below .20	48	76	46	14	8	2	8	0

^aProbabilities in the table are expressed as a percent.**Table 7. Ending Average Debt Levels for Solvent and Insolvent Iterations at a .60 Beginning Equity Ratio, Selected Capital Gain Rates, and All Credit Policies**

	Leverage Ratio					
	1.0	1.5	2.0	2.5	3.0	4.0
I. Tenant						
A. 7% Capital Gain Rate						
(1) Solvent Iterations						
Percent of All Iterations:	26	58	82	86	88	92
Average Ending Liabilities(\$):	299,600.	317,601.	370,696.	382,543.	385,643.	402,852.
Change from Beginning(\$):	6,719.	24,720.	77,815.	89,662.	92,762.	109,971.
(2) Insolvent Iterations						
Percent of All Iterations:	74	42	18	14	12	8
Average Ending Liabilities(\$):	535,374.	620,032.	652,954.	673,729.	671,065.	825,131.
Change from Beginning(\$):	242,493.	327,151.	360,073.	380,848.	378,184.	532,250.
B. -3% Capital Gain Rate						
(1) Solvent Iterations						
Percent of All Iterations:	26	58	82	84	88	92
Average Ending Liabilities(\$):	298,995.	316,987.	370,065.	376,265.	385,068.	401,501.
Change from Beginning(\$):	6,114	24,106.	77,184.	83,384.	92,187.	108,620.
(2) Insolvent Iterations						
Percent of All Iterations:	74	42	18	16	12	8
Average Ending Liabilities(\$):	550,216.	650,534.	652,822.	655,584.	670,936.	824,981.
Change from Beginning(\$):	257,335.	357,653.	359,941.	372,703.	378,055.	532,100.
II. Part-Owner						
A. 7% Capital Gain Rate						
(1) Solvent Iterations						
Percent of All Iterations	74	100	100	100	100	100
Average Ending Liabilities(\$):	1,059,635.	1,157,124.	1,155,503.	1,155,245.	1,155,222.	1,155,222.
Change from Beginning(\$):	305,099.	402,588.	400,967.	400,709.	400,686.	400,686.
(2) Insolvent Iterations						
Percent of All Iterations:	26	0	0	0	0	0
Average Ending Liabilities(\$):	1,407,643.	-	-	-	-	-
Change from Beginning(\$):	653,107.	-	-	-	-	-
B. -3% Capital Gain Rate						
(1) Solvent Iterations						
Percent of All Iterations:	22	68	88	92	96	98
Average Ending Liabilities(\$):	857,586.	930,124.	1,021,635.	1,036,390.	1,060,056.	1,070,983.
Change from Beginning (\$):	103,050.	175,588.	267,099.	281,854.	305,520.	316,447.
(2) Insolvent Iterations						
Percent of All Iterations:	78	32	12	8	4	2
Average Ending Liabilities(\$):	1,206,550.	1,359,569.	1,491,227.	1,592,420.	1,594,519.	1,648,532.
Change from Beginning(\$):	452,014.	605,033.	736,691.	837,884.	839,983.	893,996.

held by the farm operator in the last year of operation. These debt levels are particularly important to the lender, because they represent potential gains or losses to his financial institution that accompany the credit policy decision. These debt levels are reported in table 7 for both tenant and part-owner at a beginning equity level of 60 percent. The results are separated into solvent and insolvent categories to illustrate average changes in debt when the farm survives through 1988 and when insolvency occurs in or before 1988.

In every instance, average ending debt exceeded beginning debt. At a seven percent capital gain rate for land, liberalizing credit policy for tenants and part-owners resulted in ending debt for surviving iterations increasing by about \$100,000, while debt for insolvent tenant iterations increased by about \$300,000. Ending debt for all iterations was minimized at leverage ratios of 2.0 to 3.0 for tenants and was approximately the same across all leverage ratios for the part-owner.

The results were quite different for the part-owner when the capital gain rate was minus three percent. Liberalizing credit policy for the part-owner resulted in an average increase in debt of more than \$200,000 for surviving iterations and almost \$450,000 for insolvent iterations. Expected debt was minimized at a leverage ratio of 1.5. Again, tightening credit to the part-owner seems appropriate when capital gain rates are negative. The recent moves by the banking community to tighten credit in response to decreases in farmland value appear correct in light of these results.

Extension of Capital Gain Rate Scenarios

In the results reported thus far, only two capital gain rates for land have been examined. While insightful, the two rates examined hardly represent the full range of possibilities that could occur between 1984-1988. To understand the relationship of capital gains for land to farm survival, as well as the combined influences of beginning equity and credit policy on survival, four additional capital gain rates were examined for each beginning equity-credit policy combination. These rates were minus seven percent; zero percent; three percent, and 10 percent per year.

Rather than reporting and attempting to interpret results for the different beginning equity, credit policy, and capital gain rate combinations, the results were combined with those for the seven percent and minus three percent rates and then analyzed using ordinary least-squares regression techniques. The data were fit to a quadratic function because of its ease in estimation and interpretation and because the functional form is flexible in approximating the actual functional relationship. The corresponding minimum equity ratios were substituted for leverage ratios in representing credit policy, so as to facilitate comparison between credit policy and beginning equity. The estimated equations are:

$$S_T = -14.944 + 2.896BE - 0.0163BE^2 - 1.815ME \\ (16.918) \quad (0.266) \quad (0.0018) \quad (0.832)$$

$$-0.00183ME^2 + 0.0779CG + 0.00099CG^2 \\ (0.01116) \quad (0.7303) \quad (0.0554)$$

$$-0.000335CG*ME - 0.000664CG*BE \\ (0.01735) \quad (0.0065)$$

$$+ 0.01608ME*BE \\ (0.0039)$$

$$S_P = -49.781 + 3.984BE - 0.0242BE^2 - 1.692ME^2 \\ (20.436) \quad (0.367) \quad (0.0023) \quad (1.001)$$

$$+ 0.00111ME^2 + 3.365CG + 0.00691CG^2 \\ (0.0134) \quad (0.897) \quad (0.041)$$

$$-0.0228CG*ME - 0.0255CG*BE \\ (0.021) \quad (0.009)$$

$$+ 0.0148BE*ME \\ (0.0052)$$

Where S_T = Probability of survival for the tenant, $0 \leq S_T \leq 100$

S_P = Probability of survival for the part-owner, $0 \leq S_P \leq 100$

BE = Beginning equity ratio (times 100) $0 \leq BE \leq 100$ for tenant, $0 \leq BE \leq 90$ for part-owner

ME = Minimum equity ratio (times 100), $0 \leq ME \leq 100$

CG = Percent capital gain rate

The numbers in parentheses are the standard errors for the corresponding coefficients.⁶ R^2 values were .932 and .868 for the tenant and part-owner equations, respectively. Results for 100 percent beginning equity were not used in the part-owner equation because no variation in survivability occurred between this level and the 90 percent beginning equity level.

The estimated coefficients and their standard errors in both equations suggest credit policy and capital gain rate for land are linearly related to farm survival, with beginning equity apparently exhibiting a nonlinear relationship. The small coefficients for all capital gain variables appearing in the tenant equation suggest this variable had little impact on tenant survival. As noted previously, large changes in the value of land would have little impact on the tenant farmer operation since land represented only two percent of total farm assets. The interaction terms between beginning equity and credit policy were positive, implying beginning equity became more important to the farm

operator as credit policy was tightened. The interaction terms between beginning equity and capital gains were negative, suggesting the value of capital gains to survival of the part-owner diminished as beginning equity increased. Alternatively, beginning equity became less important as capital gains increased.

Elasticities of survival provide additional insights into the relative influence of the three variables on farm survival. Elasticities of survival for selected beginning equity credit policy, and capital gain rate levels are given in table 8. At a 50 percent beginning equity level and three percent capital gain rate, both tenant and part-owner operations were approximately equally sensitive to changes in beginning equity for the range of credit policy options. When the capital gain rate decreased to minus three percent or beginning equity fell to 35 percent, the part-owner became more sensitive to changes in beginning equity. Similarly, both tenant and part-owner were equally sensitive to changes in credit policy, with values for the part-owner being somewhat more inelastic. Note, however, that the elasticities with respect to beginning equity were always larger than the elasticities with respect to credit policy. This result suggests survival of tenant and part-owner is more influenced by their financial position than lender's credit policy.

Elasticities of survival were small for changes

⁶Candler and Cartwright state: "In a non-stochastic [simulation] model, the standard errors obtained from least-squares regression have no meaning." In fact, standard errors from simulated data may provide some indication as the strength of fit for each coefficient, but cannot be used in conjunction with t-tables to test for significance.

Table 8. Elasticities of Survival for Tenant and Part-Owner at Selected Beginning Equity, Credit Policy, and Capital Gain Rate Levels

Scenarios	Elasticity with Respect to a Change in:					
	Beginning Equity		Credit Policy		Capital Gain Rate	
	Tenant	Part-Owner	Tenant	Part-Owner	Tenant	Part-Owner
3% Capital Gain Rate, 50% Beginning Equity, Minimum Required Equity of:						
50%	1.99	2.37	-1.09	-0.97	.002	.061
33%	1.66	1.57	-0.67	-0.50	.002	.066
20%	.92	1.18	-0.25	-0.26	.002	.067
3% Capital Gain Rate, 33% Minimum Equity, Beginning Equity of:						
35%	1.86	3.38	-1.02	-1.38	.003	.189
65%	1.10	0.93	-0.36	-0.28	.001	.034
50% Beginning Equity, 33% Minimum Equity, -3% Capital Gain Rate	1.68	1.94	-0.67	-0.49	-.002	-.071

in the capital gain rate, although changes in beginning equity resulted in relatively large changes in elasticity.

Summary and Implications

The principal objective of this paper was to examine the effects of beginning equity, credit policy, and capital gain rates for land on the survivability and ending equity position of a representative Texas rice and soybean farm. Beginning equity was the predominant variable of the three in determining whether the farm operator will survive the next five years. Both tenant and part-owner operations were much more sensitive to changes in beginning equity than they were to changes in credit policy or capital gain rate for land.

Credit policy is only important to farmers at intermediate beginning equity levels. At high beginning equity levels, both part-owners and tenants survive regardless of the credit policy. At low beginning equity, neither type of farm operation will likely survive, no matter how liberal the credit policy. This result holds particularly for the part-owner operations, which offer little promise of improving on beginning equity position but do invite a high probability of sliding into a very deep debt situation. Tenant operations, while presenting a greater risk of losing all remaining equity, also offer a higher probability of improving on the beginning equity situation than do the part-owner operations.

Performance of the part-owner versus tenant operations is closely tied to the capital gain rate for land. A high rate causes part-owner operations to perform much better than tenant operations, even at low beginning equity levels. At negative capital gain rates, however, part-owners are much more dependent than are tenants on beginning equity for continued farm survival. Tightening credit seems appropriate when capital gain rates are negative.

Results for the representative farm suggest a credit policy leverage ratio of 1.0 is too restrictive, because it forces farm operations into insolvency that would probably recover if given a chance. A credit policy of 4.0, on the other hand, is probably too lax because it allows farm operators in a high debt position

to continue farming, even though there is little chance the operators can achieve an acceptable equity position. The 2.0 leverage ratio appears to offer lenders a reasonable credit policy alternative, liquidating farm operations with little hope of recovery from financial trouble but permitting sufficient credit to allow recovery from bad years.

It is not known, of course, how representative these results are for farms across the country. If they are somewhat representative of the national situation, however, the results suggest a very real crisis for U.S. agriculture. According to a recent survey, 32 percent of bank farm customers have equity ratios of less than .40, with an additional 29 percent having equity ratios between .40 and .60 (Doane Publishing). Given the results from this study, several recommendations can be made: (a) any proposed debt relief program should be targeted, because farm operators in a low debt position simply do not need assistance; (b) given the current course of events, nothing short of a massive buy-down of debt or large increases in capital gain rates on land will save farm operators in a high debt situation from insolvency; and (c) because declines in land value (i.e., a negative capital gain rate) are partly responsible for the current debt crisis, policies aimed at halting or reversing this decline may prove as effective as current proposals in dealing with the debt crisis. In this light, it is ironic to note the move to slash farm subsidies currently in vogue among government policymakers. Because of low farm prices over the last few years, the target price has become the expected return to the farmer. A cut in the target will not only reduce farm income but will cause land values in some areas to further erode, causing the debt crisis to become even more severe in those areas.

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Machinery Lease Versus Purchase Decisions Under Risk

Glenn D. Pederson

Abstract

Recent changes in tax treatment of financial leases and the cost of debt financing have altered the incentives to lease machinery. Conventional lease versus purchase analyses have not considered risk associated with fluctuating taxable income (hence, tax benefits under each financing alternative) and changing interest rates. A simulation model was developed to evaluate the distribution of net present costs under various taxable income-interest rate scenarios. Results indicate that fluctuation of taxable income, interest rate movements, and risk preferences of lessees alter the preferred financing alternative.

Key words: leasing, risk, taxes, simulation

Farmer interest in machinery, equipment, and structure leasing has developed for three reasons. First, tax law changes altered the financial incentives to lease. The Economic Recovery Act of 1981 (ERTA) and the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) changed the definition of a financial lease, use of depreciation allowances, use of investment tax credit, and transferability of tax benefits through leasing. Second, use of leasing increased in response to higher, more variable interest rates. Farmers who needed to acquire additional machinery sought financing alternatives other than additional debt. Third, rising machinery and equipment costs placed additional pressure on available cash flow, leaving little to meet the down payment requirements on new assets. A financial lease is a potential means of acquiring additional machinery capacity with a reduced initial cash requirement.

Previous studies have considered the potential advantages and disadvantages of financial leasing (LaDue, 1982; Plaxico, Walsh). Potential advantages include altered cash flow timing, improved working capital position, and improved tax treatment through transfer of tax benefits. Potential disadvantages are relatively higher cost associated with some leasing arrangements, problems of anticipating what asset residual values will be at lease termination, and the fixed nature of a financial lease obligation. Prior studies have recognized that most leasing arrangements are tax motivated. Situations in which leasing is viable are expected to involve individuals and businesses that do not have identical tax brackets or costs of capital. Differing tax rates can result in advantages to leasing even when both parties are able to utilize available tax deductions and credits.¹

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Lease versus purchase analyses typically have utilized a cash flow approach (Schoney and Massie; LaDue, 1977; LaDue, 1979; Willett and Penland; Schoney). Conventional cash flow analysis can follow either of two methodologies. One can estimate the after-tax present value cost difference between the lease and purchase and accept the alternative which generates a cost savings. Alternatively, the model may be formulated to solve for the after-tax, interest cost equivalents of the loan and lease (Wyman).² The rate equivalent for the lease then could be compared with that of the loan or the firm's after-tax cost of term debt. Leases which result in financing rates higher than the equivalent rate on debt could be rejected, other factors held constant.

Conventional capital budgeting analyses have concentrated on analyzing mean cash flows. Riskiness of cash flows has been implicitly recognized by incorporating a risk premium in the discount rate (risk-adjusted discount rate). Three potential problems with this approach are worth considering. First, use of a risky discount rate employs the specific assumption that risk premiums change annually at the same rate as present value factors adjust over time, holding the risky discount rate constant. Second, a risk-adjusted discount rate yields only a point estimate of project profitability. Decision makers may be sensitive to the distribution of present value outcomes. Parameters of the present value distribution are not forthcoming from conventional analysis unless additional assumptions are made about the distribution of risk premiums for the investor. Third, determination of an appropriate risk premium is, itself, a significant problem. Use of a market interest rate as a proxy for the risky discount rate

may reduce the applicability of the results if there is a lack of correspondence between the market risk premium and the individual's risk preferences.

Anderson et. al. suggest that naive models (such as the risky discount rate approach) should not be used and that three other analytical approaches are preferable. Those three approaches are (a) multidimensional utility appraisal of risky cash flow sequences, (b) mathematical programming, and (c) utility appraisal of net present value distributions using risk efficiency criteria.³ Ranking net present value distributions using the axioms of expected utility theory requires that certain capital market assumptions be made to render the analysis theoretically correct.⁴ Other agricultural research applications have employed simulation and risk efficiency tools for ranking investment alternatives based on net present value measures (Boggess and Amerling).

This paper approaches the decision to lease or purchase farm machinery by explicitly modeling risky cash flows over time. These risky annual flows are discounted using a risk-free rate to avoid double-counting for risk. The limited objective of this paper is to evaluate how taxable income and interest rate fluctuations during the investment period influence the financing choice for certain classes of decision makers. Subsequent sections of the paper explore various components of risk, describe the simulation model that was developed, and review the rankings of financing choices under risk.

Risk Components

Financial leases are long-term arrangements between a lessor (leasing company, financial institution, or equipment dealer) and a lessee (farmer). The benefits of leasing are subject to change as a farmer's financial and

¹Dunn and Watts demonstrated that advantages to leasing exist if the lessor is in a higher tax bracket than the lessee. The benefits of the leasing transaction derive from the sequence of fixed costs, accelerated depreciation allowances, and utilization of the investment tax credit.

²A lease transfers significant tax benefits of ownership to the lessor; the farmer's tax position under a lease will differ from that which would result with a purchase. As a consequence, annual percentage rate (APR) comparisons between lease and purchase financing costs can be misleading. The APR is a before-tax interest rate concept and should be utilized only when comparing leases or comparing loans which are subject to similar tax treatment.

³Anderson et. al. argue that the multidimensional (state-time preference) utility approach is the only one which is valid. However, due to its complexity the authors suggest that simulation of net present value distributions and use of risk efficiency tools for evaluation of alternatives is acceptable.

⁴It is highly unlikely that capital markets perform according to the perfect capital market assumptions (perfectly competitive, zero transaction costs, complete and costless information, and equivalent rates on borrowed and loaned funds).

tax positions change over the life of the lease or loan transaction.

Fluctuating taxable income directly influences the cost of lease and loan financing alternatives by increasing or diminishing their tax benefits and net, after-tax financing costs. Tax benefits for lessees include lease payment deductions, while tax benefits of ownership include interest payment deductions, depreciation allowances, and availability of the investment tax credit.

As taxable income varies above its expected level, tax benefits increase and net, after-tax financing costs decrease. Due to progressive graduation of the income tax, however, the potential tax savings associated with deductibility of ownership or leasing costs will vary depending on the direction of change in income. That is, the increase in taxes associated with an increase in income of a given magnitude will be greater than the reduction in taxes due to a decline in income of the same magnitude, other factors held constant. The availability and use of tax benefits under the loan and lease alternatives will modify the related distributions of financing costs as incomes fluctuate over time. Progressivity of the income tax and ability to carry over unused tax benefits (or net operating losses) may well lead to redistributions of financing costs which are difficult to incorporate when using a nonstochastic method of analysis. The resulting distributions of net, after-tax financing costs may be significantly nonnormal, creating a problem for the investor who is not risk-neutral.

Financial institutions are using adjustable interest rates on farm loans to reduce their interest rate risk exposure. The resulting interest rate variability takes on additional significance in the lease versus purchase decision, since lease rates are usually fixed over the financing period and loan rates are periodically adjusted to reflect current market interest rates. The preferred financing alternative is potentially altered by the direction and magnitude of future interest rate movements and their differential impacts on debt and leasing costs.

The residual value of the asset represents a potentially important source of risk in

addition to taxable income and interest rate variability. For example, if the cost of a machine increases over the life of the lease, the residual value also is expected to increase. When this increase is not anticipated the farmer will pay a higher-than-expected amount to purchase the asset for its remaining useful life under a fair market value purchase option. A farmer can limit or eliminate residual value risk through the use of a fixed price purchase option.⁵

The Simulation Model

A mathematical simulation model was formulated to analyze the farmer's lease versus purchase decision under risk. The model was developed as a conventional capital budgeting analysis with refinements to incorporate current tax law provisions and randomness of taxable income. The conventional discounted cash flow formulation can be mathematically expressed for the purchase (with a loan) and lease alternatives. The net present cost (NPC) of the purchase is:

$$\text{NPC (loan)} = D_0 + \sum_{m=0}^M \frac{D_m}{(1+r)^m} - t \sum_{m=0}^M \frac{(A_m + I_m)}{(1+r)^m} - \frac{C_q}{(1+r)^q} \quad (1)$$

where, D_0 = cash down payment
 D_m = debt repayment (principal and interest) in period m
 t = marginal tax rate
 A_m = depreciation taken in period m
 I_m = interest payment in period m
 C_q = investment tax credit in period q
 r = discount rate
 m = period (in years)

Annual reductions in outflows (due to reduced taxes) are deducted from annual cash outflows to derive the net, after-tax flows. These flows are then discounted to compute the appropriate net present cost. Similarly, the net present cost of the lease is:

⁵The option to purchase the asset at lease termination for a price which is known in advance effectively eliminates residual value risk as a major source of risk for the farmer (lessee), and is not considered as part of this study. In effect the risk of changing residual value is shifted to the lessor, who may in turn adjust the lease rate to include a residual value risk premium.

$$\text{NPC (lease)} = \sum_{n=0}^N \frac{LP_n}{(1+r)^n} + \frac{S_N}{(1+r)^N} - t \left(\sum_{n=0}^N \frac{LP_n}{(1+r)^n} + \sum_{m=N+1}^M \frac{R_m}{(1+r)^m} \right) \quad (2)$$

where, LP_n = annual lease payment in period n
 S_N = amount of purchase option in period N
 R_m = depreciation allowance in period m associated with the lease purchase option
 n, m = periods (in years)

Cash outflows of the lease are lease payments and the fixed price purchase at lease termination. Corresponding reductions of outflows include the stream of tax benefits due to deductibility of lease payments and depreciation (if the leased asset is purchased).⁶

Tax benefits and net present costs of leasing and purchasing are uncertain if interest rates, taxable incomes, and therefore, tax rates, are random. The model expressed by equations 1 and 2 is modified to include uncertain tax benefits and variability of interest payments, as shown in equations 3 and 4.

$$\text{NPC (loan)}_k = D_o + \sum_{m=0}^M \frac{\bar{D}_m}{(1+r)^m} - \sum_{m=0}^M \frac{\bar{t}_m (A_m + \bar{I}_m)}{(1+r)^m} - \frac{C_q}{(1+r)^q} \quad (3)$$

$$\text{NPC (lease)}_k = \sum_{n=0}^N \frac{LP_n}{(1+r)^n} + \frac{S_N}{(1+r)^N} - \left(\sum_{n=0}^N \frac{\bar{t}_n LP_n}{(1+r)^n} + \sum_{m=N+1}^M \frac{\bar{t}_m R_m}{(1+r)^m} \right) \quad (4)$$

where, $\bar{D}_m$ = uncertain debt repayment in period m
 $\bar{t}$ = random tax bracket
 k = the observation of the random net present cost

The discounted cash flow framework under risk which is described by equations 3 and 4 forms the basis for the simulation model to evaluate farmer preferences for leasing or purchasing depreciable assets.

An interactive simulation program was developed to generate a quasirandom sequence of taxable incomes. Taxable incomes were simulated based on estimated historical distribution parameters that are representative of North Dakota cash crop operators during 1981-1983 (Pederson, et. al.). Although the historical distribution estimates indicated large variability and significant right-tail skewness for all farms, these parameters were modified for simulation purposes. Only the range (minimum taxable income through the 95th percentile) was utilized.⁷ Upper and lower bounds of the taxable income distributions were set three standard deviations from the assumed mean as shown in table 1. A Beta distribution was used to generate the random taxable income sequences, since it is sufficiently flexible to replicate symmetric (or nonsymmetric) distributions.

Taxable income distributions were paired with specific machinery costs to represent financing situations that are considered representative of various actual investment situations (table 1). Machinery costs are representative of various sizes of farm tractors for which new costs vary from \$51,000 for a 135-horsepower, two-wheel-drive tractor to \$130,000 for a 300-horsepower, four-wheel-drive tractor. The simulation model was used deterministically to identify mean taxable income levels at which the after-tax financing costs of the loan and lease alternatives are sufficiently close to merit a risk analysis. All model parameters were held fixed while a constant (over the period of analysis) taxable income was systematically adjusted until the net, after-tax financing costs of the two financing

⁶Specification of equations 1 and 2 jointly imply incremental cash flows for the lease alternative. The planning horizon for the lease is necessarily extended to capture the tax benefits associated with purchasing the asset at the end of the lease contract period. A facilitating assumption was made that the investment (in this case a tractor) has a minimum useful economic life of 10 years.

⁷Taxable incomes derived from 660 farm business summaries were statistically analyzed. The adjusted mean taxable income was \$14,273 (after taking the standard deduction for a family of four and making adjustments for IRA contributions, but before use of the investment tax credit) for operators with taxable incomes above the minimum (zero-bracket) level of \$3,400. The median taxable income was \$8,988 and the 95th percentile was \$47,216. Farmers above the zero-bracket level represented approximately 23 percent of all farms which were analyzed.

Table 1. Taxable Income-Machinery Cost Scenarios

Scenario	Machinery Cost	Expected Taxable Income	Standard Deviation of Income	Income Bounds	
				Lower	Upper
I	\$ 51,000	\$13,650	\$3,416	\$3,400	\$23,900
II	76,500	18,450	4,610	4,620	32,280
III	130,000	28,450	7,106	7,130	49,770

alternatives were approximately equal. Other parameters of the taxable income distribution were subsequently set based on somewhat arbitrary assumptions about the magnitude of income variability.

The stochastic simulation model was used recursively to randomly draw sequences of taxable income for the lease and purchase net present cost computations. The model produced 100 iterations to generate a distribution of net present cost for each alternative under each set of model assumptions. The frequency distributions of net present costs were derived and summed over the range of outcomes to generate separate cumulative distributions for the lease and purchase financing alternatives. Cumulative distributions were ranked for classes of decision makers with different risk preferences using stochastic dominance with respect to a function.⁸

Three interest rate environments were evaluated using the model. Interest rates were allowed to vary deterministically, not as random variables in the simulation model. All three interest rate environments were based on average annual loan rates charged on machinery by a representative Production Credit Association between 1973 and 1981. The constant interest rate environment assumes rates hold constant at 12.8 percent. The rising interest rate environment allows the annual rate to increase by one percent per year from 12.8 percent in the initial year to 16.8 percent in the fifth year of the loan. The falling interest rate environment allows the annual rate to fall one percent each year from 12.8 percent to 8.8 percent in the fifth year of the simulation.

⁸Stochastic dominance with respect to a function allows the decision maker to rank risky alternatives through a pairwise comparison of cumulative probability distributions given the assumption of constant absolute risk aversion over a defined set of payoffs (Meyer).

The lease was structured as a fixed-rate contract. Lease rates vary considerably, therefore, lessors that offer both leases and loans were contacted to determine what terms are representative of farm machinery leases. Responses indicated that lease rates are typically set at two to two and one-half percent spread over initial interest rates on loans of equal maturity. The before-tax lease objective was, therefore, set at 2.2 percent over the initial loan rate (or 15 percent) for all simulations.

In all simulations the lessor was assumed to take the investment tax credit and depreciate the leased asset using accelerated cost recovery rates. The fixed purchase price option under the lease was set at 15 percent of the original cost of the asset. The down payment requirement under the loan was held at 20 percent of the initial cost. Use of debt was not considered under the lease at the time of the buyout.

A riskless discount rate was used to discount project cash flows in all simulations. The average one-year Treasury bill rate between 1977 and 1983 (9.6 percent) was used (Federal Reserve). The average T-bill rate was adjusted downward by the marginal tax rate in each period of the analysis to approximate an after-tax, risk-free rate.

Simulation Results

Summary statistics for the lease and purchase cost distributions are shown in table 2. Mean net present costs of the lease and purchase distributions were nearly equal in all scenarios which assumed constant interest rates (panel A). The small mean value difference reflects the similarity of the lease and loan terms specified in the model and the fixed interest rate loan assumption initially employed in the analysis. Standard deviation was more than twice as great for the purchase alternative due to the relatively

Table 2. Summary Statistics of Net Present Cost Distributions For Three Taxable Income-Machinery Cost Scenarios and Selected Interest Rate Environments

Taxable Income-Machinery Cost Scenario	Financing Alternative	Mean	Standard Deviation	Skewness
Panel A (Constant Interest Rates)				
I	Lease	\$ 45,203	\$ 747	.406
	Loan	45,585	1,690	.163
II	Lease	\$ 65,313	\$ 944	.124
	Loan	65,647	2,576	.058
III	Lease	\$103,476	\$2,183	.135
	Loan	103,231	5,653	-.176
Panel B (Rising Interest Rates)				
I	Lease	\$ 45,203	\$ 747	.406
	Loan	47,078	1,705	.115
II	Lease	\$ 65,313	\$ 944	.124
	Loan	67,840	2,594	-.023
III	Lease	\$103,476	\$2,183	.135
	Loan	107,198	5,651	-.157
Panel C (Falling Interest Rates)				
I	Lease	\$ 45,203	\$ 747	.406
	Loan	44,195	1,712	.101
II	Lease	\$ 65,313	\$ 944	.124
	Loan	63,475	2,583	.042
III	Lease	\$103,476	\$2,183	.135
	Loan	99,705	5,652	-.068

greater importance of ownership tax benefits in reducing financing costs when incomes were allowed to fluctuate. The standard deviation is a useful statistic for identifying the preferred financing alternative when the underlying distribution of present costs is approximately symmetrical.

Skewness statistics indicated that the simulated cost distributions were not symmetric about the mean under any of the taxable income-machinery cost scenarios. Most distributions exhibited positive (right-tail) skewness with the lease exhibiting the greatest positive skewness in all three scenarios. The primary reason for the different shapes of the distributions was the disparity between the utilization of tax benefits as taxable income fluctuated. When taxable income randomly fluctuated above the mean income level, tax benefits increased proportionately for both the lease and loan distributions. However, when taxable income fluctuated below the expected level some or all of the available

tax benefits were not used because tax liability was less than available tax benefits. Unused tax benefits (lease payments, interest, and depreciation) were carried forward to subsequent years as annual net operating losses. Excess investment tax credit was also carried forward. The present value of tax benefits carried forward was, of course, lower due to discounting. The necessity of carrying benefits forward in low income years had a relatively greater impact on the loan financing alternative which had somewhat larger annual tax benefits.

The net present cost distributions were ranked for decision makers with different risk preferences under three interest rate environments as shown in table 3.⁹ Rankings

⁹Coefficients of absolute risk aversion used in the stochastic dominance analysis were selected based on prior studies of farmers' risk preferences. The coefficient bounds were set for three classes of decision makers as follows: (a) risk-averse (0, .002), (b) risk neutral (0, 0), and (c) risk-prefering (-.0002, 0).

Table 3. Preferred Financing Choices For Alternative Interest Rate Environments

Taxable Income-Machinery Cost Scenario	Risk-Averse	Risk-Neutral	Risk-Preferring
Panel A (Constant Interest Rates)^a			
I	Lease	Lease	Lease
II	Lease	Lease	Indifferent
III	Indifferent	Loan	Loan
Panel B (Rising Interest Rates)			
I	Lease	Lease	Lease
II	Lease	Lease	Lease
III	Lease	Lease	Lease
Panel C (Falling Interest Rates)			
I	Indifferent	Loan	Loan
II	Indifferent	Loan	Loan
III	Indifferent	Loan	Loan

^aCorresponding statistical estimates for the constant interest rate net present cost distributions are shown in table 2.

with constant interest rates (panel A) indicated that the lease financing alternative would be selected by risk-neutral farmers under Scenarios I and II, but the loan would be preferred under the high income-high machinery cost scenario (III). The risk-neutral class of farmers would rank highest the alternative which yields the lowest mean cost (mean dominance). The risk-averse class of farmers would rank the lease alternative first under Scenarios I and II, but would be indifferent between the two choices under Scenario III. The reason for this indifference in Scenario III is reflected in the lower mean cost and negative skewness (which favor the loan), and the correspondingly higher variability of those costs under the loan (which favors the lease alternative). Risk-preferring farmers (as a class of decision makers) demonstrated no consistent preference for the loan or lease alternative due to changes in the parameters of the underlying cost distributions. The lower mean costs with the lease in Scenario I compensated risk-preferrers for the loss of probability at lower cost levels (left-tail). Lower mean costs, larger variability, and negative skewness of the cost distribution all made the loan the preferred alternative for risk-preferring farmers in Scenario III.

Simulation results for the rising interest rate environment (panel B) indicated that a wide risk class of farmers would prefer the lease over the loan. The primary reasons for this preference were the lower mean costs and lower relative variability under the lease financing alternative. The major effect of

rising interest rates was to raise the mean costs of the loan without appreciably changing the associated standard deviation. Higher mean cost in the rising interest rate environment reflects the combined effects of higher interest costs and limited deductibility of those increased financing costs from the same sequence of random taxable incomes.

A falling interest rate environment reversed the ranking of financing alternatives. Falling interest rates reduced the combined mean costs without significantly affecting variability under the loan financing option. The decline of interest rates over the life of the loan reduced the probability of high cost levels. The shift of probability to the left tail of the cost distribution is apparent in Scenarios II and III due to lower annual interest costs relative to the level of taxable income. The class of risk-averse farmers would have difficulty ranking these two financing choices as reflected by the uniform indifference shown in panel C over all taxable income-machinery cost scenarios.

Conclusions

Prior research indicates that financial leasing has become a relatively more attractive financing alternative for farmers due to recent changes in tax laws and economic conditions. Previous studies of the lease versus purchase decision have not adequately incorporated risk factors into the cash flow analysis. This paper presented a simulation model and results which included risk associated with taxable income variation

and changing interest rates. Simulation results illustrated that these factors can significantly alter the distribution of costs and potentially alter the preferred financing alternative. The reported risk analysis was based on specific taxable income distribution-machinery cost scenarios within which the two financing options were roughly equivalent in terms of present value of costs. In this framework the comparison of financing options within the constant interest rate environment was more heavily influenced by distributional characteristics other than the mean costs generated by each alternative. The simulation model is a useful tool in analyzing how sensitive selected financing alternatives are to different terms and risk factors.

Two additional sets of conclusions were drawn from the analysis. First, a conventional capital investment analysis of mean cash flows may provide sufficient information for farmers to select the least-cost financing alternative. A large number of taxable income-machinery cost combinations could be identified which would not be sufficiently close to warrant a risk analysis. A conventional analysis would require less information and produce sufficient results on which to base a financing decision.

Second, preferred financing alternatives were identified using assumed risk preferences for risk classes of decision makers. No clear pattern of preference was identified for risk-averse or risk-preferring classes of farmers. Greater diversity in selection of a financing option was illustrated when loan interest rates were held constant over the life of the loan. When loan interest rates were allowed to steadily adjust upward the lease was generally preferred due to mean dominance of the associated cost distribution. The simulated variable rate loan was ranked equivalent to, or preferable to, the lease when interest rates were allowed to steadily decline. The preferred financing alternative significantly depends on a farmer's expectations of future interest rate movements in addition to the expected tax position. When considering a fixed rate lease versus a variable rate loan to finance the purchase of farm machinery, equipment, or structures, the future course of interest rates potentially far exceeds variations in taxable income and is a critical factor to evaluate in the analysis.

Some important limitations to the simulation analysis should be considered. First, the underlying distribution of taxable income is not known, although the parameters of that distribution were set based on recently analyzed farm income data. Second, assumptions about the lease arrangement (lessor tax rate, lease yield objective, and resulting lease payments) were not varied within income-machinery cost scenarios. Lease characteristics which were modeled are representative of current lease contracts. Yet, farmers are able to lease machinery and equipment from a wide range of lessors whose lease arrangements and terms vary from those employed in this study. Finally, the model assumed a fixed price purchase option which was less than the market value of the asset at lease termination. Although this is a typical situation of farm financial leases it is not representative of fair market value leases. Additional research needs to focus on the impact of residual value risk.

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Effects of Selected Macroeconomic Policies on Agriculture: 1984-1990

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Abstract

This paper describes the likely financial implications for farmers if three different macroeconomic policies are pursued to the end of the decade. The scenarios studied are intended to aid in identifying the causes of current financial difficulties in the sector rather than as forecasts of the future. Two of the scenarios assume continuing large government budget deficits. In both, financial conditions for farmers continue to deteriorate. An expansionary monetary policy, without deficit reductions, provides only a brief respite from current problems. Substantial improvement could be expected, however, if deficits are reduced and a moderate monetary policy is pursued.

Key words: farm finance, monetary policy, fiscal policy, projections of farm sector conditions, government deficits, inflation.

Farmers and ranchers continue to suffer through the longest and most severe recession in 50 years. Legislators are currently debating measures aimed at alleviating the financial stress being experienced by highly leveraged farmers. Work is also underway in formulating the 1985 farm bill. These discussions are taking place in a time of great political uncertainty; the future course of monetary and fiscal policy, for example, is a much debated issue. The time is certainly right, therefore, to look ahead to the effects that alternative macroeconomic policies will have upon the financial future of the U.S. farm sector.

The purpose of this paper is to present projections of financial conditions in the farm sector to the year 1990 under alternative macroeconomic policies. These projections are made using COMGEM, a commodity-specific general equilibrium model of the U.S. economy that places particular emphasis on agriculture. COMGEM has been used in the past to examine macroeconomic linkages between agriculture and the rest of the economy (Penson; Hughes and Adair) as well as in policy analysis and current situation and outlook work at the U.S. Department of Agriculture. An overview of this model's structure is presented in Penson, Hughes, and Romain. Due to the uncertainties attached to political and other noneconomic factors, the results presented in this paper should be considered as projections of what farm sector financial conditions would be *if* specific macroeconomic policies are pursued. *They should not necessarily be construed as forecasts of what the future will bring.* It is likely, for example, that policies as stressful to agriculture as some developed in this paper would lead to compensatory government policies which are impossible to

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predict at this time. Finally, every effort has been made to avoid making subjective evaluations of the likelihoods associated with different outcomes. Such evaluations are more in the realm of the study of politics than economics and are left to the reader.

The first section of the paper presents a brief outline of current financial conditions in the sector and the major forces that have brought them about. The next section presents projections of future financial conditions in the sector under three distinctly different sets of macroeconomic policies. The final section summarizes the paper.

Past and Current Financial Conditions in the Farm Sector

The last comprehensive long-term projections of future financial conditions in the farm sector were made back in 1979 and 1980 (Moore, et al.; Hughes, 1981). At that time, farm income had been high for almost a decade and farm real estate values nationally had increased for 25 consecutive years. The major concern at that time was the continued low current returns to farm assets. Inflation was high and growing, squeezing net farm incomes through rising production costs. However, it was also generating substantial unrealized capital gains in farm real estate.

With the concerned yet decidedly optimistic attitudes of that time, it is little wonder that these projections missed the harsh realities of the next five years at least in degree, if not in direction. Net farm income in 1980 through 1983 averaged 10 percent less than it did in 1976 through 1979. In constant dollar terms, the decline was worse, with the average falling by one-third between these two periods. Farm real estate values declined in both real and nominal terms. By the end of 1983, farm real estate values were 23 percent below their peak in real dollars and seven percent below their peak in nominal terms. Even farm debt, which continued to grow during the 1980-1982 period because of debt repayment problems, declined in 1983 by more than \$2 billion.

The seeds of current problems had been planted prior to the start of 1980, however. The announcement of a change in the operating policies of the Federal Reserve

System in late 1979 was, in retrospect, a clear signal of a new offensive against inflation. Hindsight suggests that the inherent conflicts among the fiscal policies proposed by the current administration in the early 1980s should have been clear. Plans to simultaneously reduce taxes, increase defense expenditures, and balance the budget were inconsistent and unachievable. In addition, the conflict between the resulting highly stimulative fiscal policy and a restrictive monetary policy that reduced inflation from 9.2 percent to 4.3 percent in three years is reflected in the historically high real interest rates observed during the 1980s. On an ex post basis, real interest rates on Production Credit Association (PCA) loans averaged 2.1 percent from 1976 through 1979 as opposed to 6.3 percent from 1980 through 1983. On an ex ante basis, the change may have been even greater, given expectations of rising inflation prior to 1979 versus the flat to declining expectations of future inflation today.

Net farm incomes and farm asset values have been strongly influenced by these high real interest rates. Farming is one of the few businesses in the nation that is sensitive to both interest rates and export demand. Rising interest rates influence net farm income in several ways (Hughes and Adair). The most direct impact is to increase interest expenses associated with servicing the over \$200 billion in outstanding farm debt. Another important impact is the influence that higher interest rates have on farm revenues through the level of prices farmers receive. Higher real interest rates in the U.S. induce foreign investment in U.S. securities. To buy these securities, foreigners need more dollars. This bids up the value of the U.S. dollar relative to the value of other currencies.¹ A stronger U.S. dollar translates into an increase in the cost of U.S. agricultural exports, which reduces foreign demand for these products. Higher U.S. interest rates may also have precipitated a crisis in Third World countries that have been borrowing to finance both capital and human development. Their current debt repayment problems have forced them to reduce their imports of U.S. farm products.

¹There are, of course, other factors that also explain a higher value of the U.S. dollar. These include: lower inflation in the U.S. relative to other currencies and, to some extent, political uncertainties in foreign countries.

Added to these declines in foreign demand, a decline in domestic demand has resulted from reduced growth in consumer incomes and higher inventory carrying costs. Thus, farm prices and net farm income have been hurt by the high interest rates caused largely by conflicts between monetary and fiscal policies.

Farm asset values in the 1980s have also suffered from these high interest rates. The profitability of investing in farm assets has declined at the same time the cost of borrowing has increased. The combination of these two factors has led to an almost catatonic land market in many regions of the country and raised concerns of possible price declines below long-term equilibrium levels.

Since the middle of 1983, the general economy has seen a period of vigorous growth. This growth has had little effect on the financial condition of farmers, however. Real GNP grew at an annualized rate of more than six percent in the second half of 1983 and is expected to grow between six and seven percent in 1984. Yet net cash farm income in 1983, even with the Payment-in-Kind program, was not substantially higher than the levels observed in 1981 and 1982; nor is it expected to be in 1984 or 1985.

It might seem a contradiction to argue that macroeconomic policies have caused the decline in farm profitability, and yet not to expect improved macroeconomic conditions to help the sector. The reason for this is that macroeconomic policies are responsible not only for the size of the economic pie, but also for partially determining the size and distribution of its slices. A given level or rate of growth in real GNP can be accomplished by an infinite number of combinations of fiscal and monetary policies. Each combination, however, will generate different levels of interest rates, consumption, investment, and savings.

Current conflicts between monetary and fiscal policies have a definite bias against interest rate sensitive and export sensitive industries. Since agriculture is sensitive to both variables, financial resources are flowing out of the sector to finance nonfarm activities. Financial resources are fluid, and generally lead eventual adjustments in

physical resources. During 1981 and 1982, the entire economy was struggling through the worst recession since the Great Depression. While farmers were having difficulties, they at least knew they were not alone. Since mid-1983, however, profitability has returned to many other sectors in the U.S. economy. Capital has been flowing into these sectors to meet their growing demands. These flows have helped keep real interest rates high and thus have postponed any recovery in the farm sector.

Substantial problems currently exist in farm loan markets. Surveys show two to three times the normal proportion of farmers are leaving the sector, either voluntarily or through forced sales (Federal Reserve Bank of Kansas City and Federal Reserve Bank of Chicago). Farm loan losses at banks and the Farm Credit System have grown dramatically (Melichar, Irwin). Delinquencies at the Farmers Home Administration now exceed 30 percent.

In short, the current financial health of the farm sector can be characterized as poor. Constant dollar incomes have been low for five consecutive years, asset values are declining, and debts are overdue.

Projections of Future Financial Conditions in the Farm Sector

Policy prescriptions are being formulated in response to these problems. To create policies that do more than simply react to past conditions, we need to know more about future economic conditions in the sector. Little will be gained by implementing policies that simply postpone adjustments if these adjustments will in all likelihood be required in the future. In fact, harm can be done if government intervention eventually compresses these adjustments into a shorter time period.

Three projections of the future are presented in this section. The first scenario assumes an adherence to expansionary fiscal policies and restrictive monetary policies (i.e., the EFRM scenario). Such policies would be reflected in continued high government deficits and a slow growth in the money

supply to fight against inflation. Current inflation is still between four and five percent (a level that was high enough to trigger the Nixon Administration's price and wage controls in the early 1970s). Thus, it is not difficult to imagine continued slow growth in money and credit. The second scenario assumes an adherence to expansionary monetary and fiscal policies (i.e., the EFEM scenario). These policies lead to continued high deficits, but a faster growth in the money supply. Past history reveals that periods of slow economic growth and low inflation are often followed by periods of rapid growth and higher inflation. Moreover, the continued fight against inflation by restrictive monetary policy (assumed in the first scenario) could be curtailed by a potential collapse of international financial markets. Finally, the third scenario assumes an adherence to a restrictive fiscal policy and a moderate monetary policy (i.e., the RFMM scenario). These policies would lead to decreases in the budget deficit and a money supply which falls between those given by the restrictive monetary policies in the EFRM scenario and the expansionary monetary policies in the EFEM scenario. The RFMM scenario represents an admittedly optimistic view of the future, but one which has some chance of occurring.

No attempt is made to out-guess farm policymakers in these scenarios. Farm policies are identical across all three scenarios; each reflects 1984 levels of support, excluding the delayed impact of the 1983 Payment-in-Kind program. No surprises in either energy prices or weather are assumed in these scenarios, although some shocks are likely to occur over the remainder of this decade.²

EFRM: High Deficits and Slow Growth in Money

The annual government budget deficit in this scenario is held at its 1984 level in real terms through 1990. Monetary policy is constructed to eliminate inflation by 1987, and then hold changes in the overall price level to near zero. It is, of course, highly unlikely that the

smooth transition projected for the economy in this scenario could actually be achieved. Eliminating inflation would probably introduce more volatility in the economy than the model results indicate. However, the implications for the farm sector of another period of disinflation in the face of large government deficits are clearly indicated in COMGEM's projections.

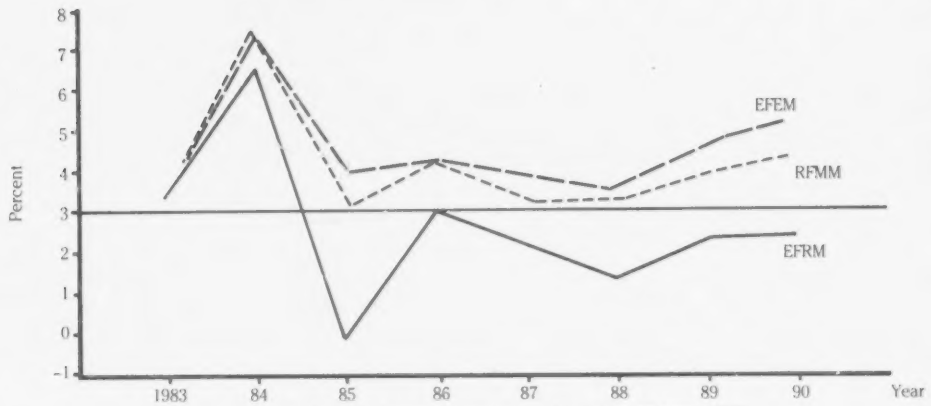
Events in the general economy. Stopping inflation in the face of continued fiscal stimulus is projected to lead to another period of slow growth and higher real interest rates for the general economy. The solid lines in panels a to c of figure 1 illustrate the trends in the percent change in real GNP, the percent change in the implicit GNP price deflator, and the real prime interest rates suggested by this scenario. Growth in real GNP, which averages 2.3 percent from 1985 to 1990, is substantially below the economy's long-run potential growth rate which is normally assumed to be about three percent. Inflation is smoothly controlled by 1987, after which the implicit GNP price deflator does not change by more than 0.2 percent annually. The real prime interest rate continues to grow throughout the period, reflecting both the continuing conflict between fiscal and monetary policy and the adjustments taken by financial intermediaries to higher costs of loanable funds.

Implications for the farm sector. The effects of continued slow growth in incomes and even higher real interest rates on the farm sector are clear: (a) lower net farm incomes, (b) declining asset values and (c) restricted use of debt financing. Panels a to c in figure 2 graphically illustrate these trends. The solid lines once again represent results from the EFRM scenario. Net farm income expressed in 1967 dollars fluctuates between \$5 and \$12 billion out to 1990 with no apparent trend. Its average over the 1981-1990 period would be \$9 billion as compared to the \$15 billion average observed during the 1971-1980 period.

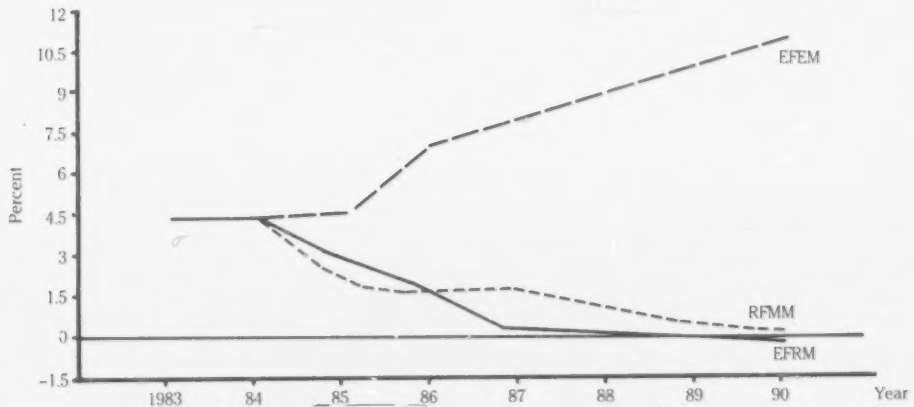
Farm asset values also decline substantially in this scenario. By 1990, they are projected to be 82 percent of their 1983 value in nominal terms and 75 percent in constant dollar terms. All of this decline takes place in physical assets, with the principal loss

²Graphs are used to present key results in this paper. A full set of tables which include projections of macroeconomic conditions, the balance sheet of the farming sector, the farm income statement and the sector's cash sources, and uses of funds statement are presented by Hughes and Penson.

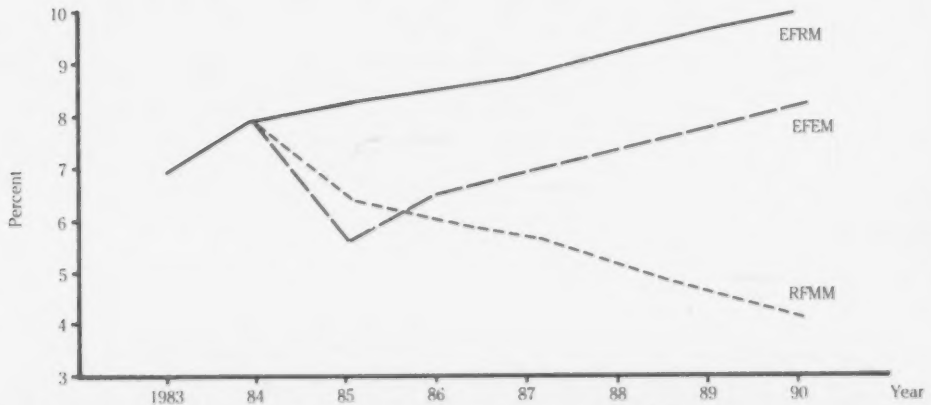
Figure 1. Projected Trends in General Economy Under Alternative Macroeconomic Policies



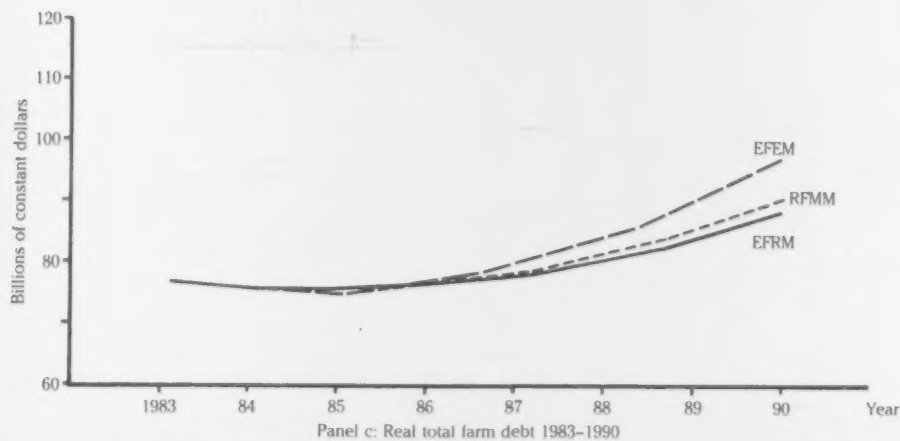
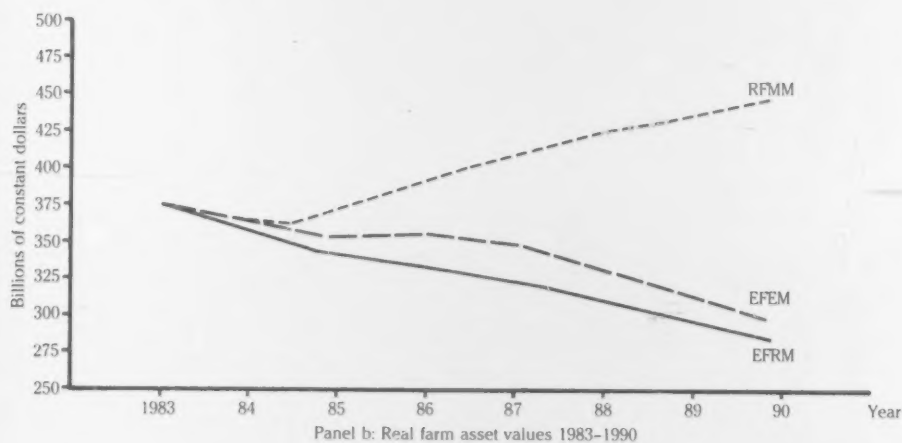
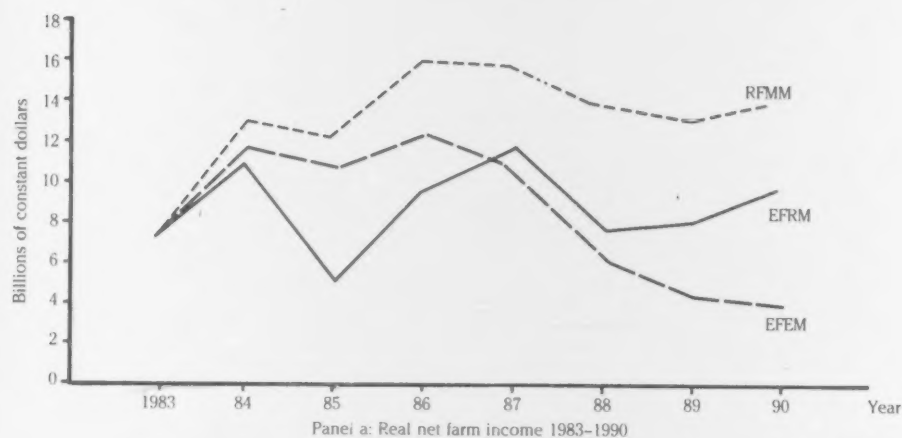
Panel a: Percent change in real GNP 1983-1990



Panel b: Percent change in GNP deflator: 1983-1990



Panel c: Ex post real prime interest rate 1983-1990

Figure 2. Projected Trends in Farm Sector Under Alternative Macroeconomic Policies

coming in farm real estate values. Financial assets grow under this scenario, reflecting the incentives for farmers to divert their available funds into nonfarm assets.

Debt is projected to grow, but at a much slower rate than experienced in the 1970s.¹ The average growth in nominal farm debt during the 1980s under this scenario would be four percent. This compares with a growth in nominal farm debt of 13 percent during the 1970s. Almost all of the projected growth in debt would be collateralized by real estate. While real estate values are declining in this scenario, it still provides the safest collateral for farm loans. Moreover, net farm incomes are projected to be so low that farmers will have difficulties repaying short-term loans and may need to refinance their debts over longer repayment periods. Such refinancing would almost certainly shift debt to the real estate category.

The net result of declining assets and increasing debt is a substantial decline in sector wealth and increasing leverage. Proprietors' equities would decline 29 percent in nominal terms and 35 percent in constant dollars. The debt-to-asset ratio for the sector is projected to grow from 21 percent in 1983 to 32 percent in 1990. Certainly the sector would have far fewer farmers without debt if these projections are realized. In addition, farmers with low debt-to-asset ratios in 1983 would likely be more highly leveraged by 1990. And those farmers who currently have moderate to high leverage ratios will likely be out of business.

Examination of projected cash sources and uses of funds in the sector also reflects adjustments in agriculture imposed by the macroeconomic policies assumed in this scenario. Capital outlays by farmers and nonfarm landlords to maintain equipment and structures and to buy farm assets from discontinuing proprietors are projected to average 79 percent of net cash income between 1985 and 1990 as opposed to the 57 percent average observed over the 1971-1979

period. The principal reason for this shift is the decline in the net inflow of loan funds. The ratio of the net flow of loan funds to total capital flow is projected to decline from the annual average of 48 percent observed in the 1970s to an annual average of 16 percent during the 1985-1990 period.

Prospects for the sector are dim if the deficit remains high for the next six years and if there is another round of fighting inflation exclusively through monetary policy. Farm incomes will likely remain low, asset values will probably continue to decline, and debt financing might be constrained. Under these conditions, the sector would probably end the decade in very weak financial health, unable to show much resilience to change and perhaps less productive than it is currently.

EFEM: High Deficits and Faster Growth in Money

Annual government budget deficits in this scenario are also held at their 1984 level in real terms through 1990. A more expansionary monetary policy that allows the inflation rate to grow at about one percent per year is assumed. The effects of these policies on the economy in general and the farm sector in particular are as follows.

Events in the general economy. The impact of these policies would be reflected largely in real interest rates; these rates first decline in 1985 and then return to 1984 levels by 1990 (dashed line in panel c of figure 1). The surprise of having monetary authorities reverse their policies is projected to allow both nominal and real rates to decline in the short run. As this new policy stance becomes generally accepted and built into expectations, however, real rates will grow to clear financial markets still servicing huge government borrowing demands. Nominal rates will grow even faster, reflecting continuing increases in inflation.

Growth in real GNP (dashed line in panel a of figure 1) is higher than the annual rates of growth in the EFRM scenario for all years. Since this growth is also higher than the sustainable three percent increase in potential GNP, it is probably being borrowed from future periods. This means that a renewed fight against inflation will likely be

¹Debt may decline under these conditions through substantial write-offs of farm loans by lenders. The model does not capture this because such actions have not occurred in the 1956-1980 period that underlie its coefficients and because the discrete nature of such actions are not included in the model's continuous functional forms.

needed sometime after 1990 to reduce GNP to its long-run growth path. Inflation (dashed line in panel b of figure 1) is held low through 1985 by policies already implemented during 1984. It is then projected to jump about 1.5 percentage points in 1986 and grow at a rate of one percentage point per year through 1990.

Implications for the farm sector. The projections of the impacts this set of macroeconomic policies will have upon the farm sector are less obvious, but perhaps more interesting than the EFRM scenario. Basically, the projections suggest that a faster growth in money helps the farm sector in the short-run (about three years), yet it is harmful to the sector over the long-run. Real net farm income (dashed line in figure 4) is projected to be higher than in the first scenario through 1986. This is principally due to higher domestic and foreign demands for food. The recession projected for the domestic economy in 1985 under the EFRM scenario is not expected with an easier monetary policy. The early reduction in U.S. real interest rates in the EFEM scenario will reduce the value of the dollar versus other currencies and stimulate the demand for agricultural exports. By 1990, however, growth in real interest rates will increase the value of the dollar, decrease export demand, and add to farmers' interest expenses. Moreover, the high rate of inflation in this scenario will generate rapid increases in farm production expenses. Long-run constraints on growth in demand and rapid increases in production expenses result in projections of real net farm incomes in the late 1980s which are substantially below those generated by either of the other two scenarios.

The decline in real farm asset values (dashed line in panel b in figure 2) with a faster growth in the money supply is slower in the first few years of the projections, but faster in later years because farm profitability is lower. One almost comforting point to note here is that projections of nominal farm asset values increase throughout the 1980s, because the rate of inflation exceeds the real price declines for land.

Growth in real farm debt is highest for this scenario, although still slower than the growth rates observed in the 1970s (dashed

line in panel c of figure 2). The average annual compound growth rate in real debt from 1984 through 1990 in this scenario is four percent, which is much lower than the six percent growth rate seen in the 1970s. The reasons for the faster growth in debt are related to farm debt repayment problems caused by the declining incomes after 1986, lower real interest rates, and slower declines in asset values than seen in the EFRM scenario. This generates more demand for debt financing and provides more collateral to allow the demand to be realized.

Examination of the cash flows and financial ratios for the EFEM scenario confirm the stories told by the sector income statement and the balance sheet. After two or three years of improved financial conditions, impacts of more rapid inflation on the sector become evident. Capital purchases start to exceed net cash income from farming in 1989. Loan funds are more highly relied upon in the late 1980s than in the first scenario. While loan funds are projected to account for an average of only 27 percent of purchased capital in 1984 through 1986, the average increases to 77 percent in 1987 through 1990. The ratio of debt outstanding to total cash income grows from 3.8 in 1983 to 6.6 in 1990. Finally, the debt-to-asset ratio for the sector increases from 21 percent in 1983 to 33 percent in 1990. Such an increase indicates that many of the same adjustments expected from the EFRM scenario would be required, even with a less restrictive monetary policy. The principal difference between the first two scenarios is that, when problems are postponed by inflating the economy, adjustments are made in a shorter period of time.

Monetizing the deficit is, therefore, probably not the solution to farm sector problems. It leaves the farm sector at the end of the decade with lower incomes, slightly higher real asset values, and more debt than if monetary policy were restrictive.

RFMM: Lower Deficits and Moderate Growth in Money

The annual government budget deficit is assumed in this scenario to be declining by about 15 percent per year in real terms through 1990 due to an assumed slowing in the growth of government expenditures.

Monetary policy is to allow a moderate growth in money, which would lead to an inflation rate of less than one percent by the end of the decade. Again, it is hard to imagine economic policymakers being able to generate the smooth transition to a noninflationary economy suggested by the model. The implications for the farm sector with such a transition, however, are enlightening.

Events in the general economy. The projected growth in real GNP in the RFMM scenario lies between the projections for the other two scenarios. It is higher than the EFRM scenario because monetary policy is less restrictive. And it is lower than the EFEM scenario because monetary policy is more restrictive and fiscal policy is less stimulative.

Inflation (dotted line in panel b of figure 1) is the driving force in developing monetary policy for this scenario. This figure shows that it rather smoothly declines to almost zero in 1990. It drops more quickly in 1985 and 1986 than in the EFRM scenario due to the reduction in fiscal stimulus to the economy. Its rate of descent is less after 1986, reflecting a less restrictive monetary policy.

Real interest rates (dotted line in panel c of figure 1) underscore the significant reductions that could be gained if monetary and fiscal policies were to work together toward a common goal. Continued reduction in government borrowing reduces the total demand for loanable funds. On the other side of the market, a less restrictive growth in the money supply adds to the supply of loanable funds in the economy. The net result is declining real interest rates throughout the period. Moreover, declines in inflation help nominal interest rates to fall even more.

Implications for the farm sector. Once again, the implications for the farm sector are clear. This scenario would lead to higher incomes, rising assets values, and moderate growth in the use of debt financing. Real net farm incomes (dotted line in panel a of figure 2) rise rapidly and then fluctuate at higher levels. While projections of real incomes do not reach the \$26 billion level of 1973, they substantially exceed the levels

achieved in the early 1980s. The projected average real net farm income over 1985–1990 period is \$14 billion compared to only \$9 billion for 1980–1983 period. The reasons for this increase can again be attributed to the interest and inflation rates. Lower interest rates decrease the value of the dollar and expand export demands. They also help increase domestic demand by holding economic growth high and inventory carrying costs low. At the same time, lower rates of inflation keep production expenses from growing rapidly. The net result is a higher level of profitability for the sector.

When higher profitability is combined with lower interest rates, farm asset values start to increase again (dotted line in panel b of figure 2). The average annual compound growth rate for real farm asset values from 1985 through 1990 for this scenario is four percent. While this is less than the six percent real growth in the 1970s, real interest rates in the scenario continue higher than those in the last decade. Most of the gain in the value of assets is in farm real estate, although machinery and equipment also show steady gains.

Almost surprisingly, outstanding farm debt (dotted line in panel c of figure 2) expressed in constant dollars shows only a moderate growth under the RFMM scenario; a 3.5 percent annual average compound growth rate over the 1985–1990 period. The reasons for this slow growth in farm debt are that more internal funds are available due to higher levels of profitability and real interest rates, while declining, continue to be high by historic standards.

Examination of cash flows and financial ratios shows the farm sector would be in much better financial condition by the end of the decade under the RFMM scenario. Purchases of capital account for only about two-thirds of net cash income. And, the ratio of debt outstanding to total cash income declines from 3.8 in 1983 to 3.0 by 1990. The sector's debt-to-asset ratio also declines from 21 percent in 1983 to 20 percent in 1990. Under the macroeconomic policies assumed in this scenario, adjustments currently underway in the sector would likely be stopped or reversed. Instead of going out of business, highly leveraged farmers and ranchers would likely do very well. Farmers

who prefer to be without debt could probably avoid borrowing. And, farmers with moderate debt-to-asset ratios would not be forced into more highly leveraged situations.

Contrary to the results under the other two scenarios, reductions in government deficits and moderate restraint in monetary policy could lead the farm sector to an improved financial condition by the end of the decade. Steady economic growth, lower inflation and lower interest rates would probably result in higher net farm incomes and asset values, and moderate growth in farm debt. This suggests that the sector could be more resilient to weather and other shocks and likely be more productive than it is today.

Summary and Concluding Comments

Current financial conditions in the farm sector indicate that some farmers are having substantial difficulties in adjusting to general economic conditions. Large government deficits and a monetary policy that has reduced the inflation rate by more than one-half in three years have changed the economic environment for farmers. While the general economy has exhibited a vigorous recovery over the last year, agriculture has not benefited. The current blend of macroeconomic policies tilts returns in the economy away from production activities sensitive to interest and exchange rates. Since farm production is one of the few sectors sensitive to both rates, it has continued to suffer even though profitability has returned to most other sectors of the economy.

What the future is likely to bring for the sector depends on decisions made about future blends of monetary and fiscal policies. Due to political and other uncertainties, point forecasts of what will actually occur were avoided. Three sets of assumptions about future macroeconomic policies were used to represent the range of possible outcomes for the farm sector through the end of the decade. The first two scenarios assumed a continuation of large government deficits. The EFRM scenario also assumed restrictions on growth in the money supply needed to quickly eliminate inflation. The EFEM scenario, on the other hand, assumed a rapid growth in the money supply that led to

higher inflation rates. The RFMM scenario was designed to look at what reducing government deficits and moderating the growth of the money supply imply for future financial conditions in the farm sector.

Both the EFRM and EFEM scenarios, which assumed the existence of large deficits, showed a farm sector with substantial financial problems at the end of the decade. Both scenarios suggested high real interest rates, low farm incomes, declining farm asset values, and some growth in farm sector leverage. Neither indicated significant declines in the production of food and fiber, but substantial dislocations in ownership patterns would likely result. If problems of the magnitude projected in these scenarios lead to ownership patterns that are significantly different from past patterns and bring in outside equity financing, risks of insolvency may eventually be reduced. These lower risks will, however, be accomplished by an ever-widening split between ownership and management in the sector.

A reduction of budget deficits and a moderate monetary policy assumed in the RFMM scenario generated significantly different results for the farm sector. Under this scenario, higher farm incomes, increasing asset values, and moderate growth in farm debt would occur. Such outcomes would likely leave the sector more productive and more capable of dealing with external shocks.

Current farm credit policy proposals that restructure debt or postpone payments may serve a useful purpose in buying some time so that more fundamental problems can be addressed. They are not, however, sufficient to solve farm sector difficulties by themselves if current macroeconomic policies are continued. In fact, the possibility exists that they may do more harm than good. Postponing farm problems by interfering in farm credit markets may compress eventual adjustments into a shorter time period and lead to greater dislocations and human suffering. Only a more restrictive fiscal policy and less restrictive monetary policy appear to permanently alleviate the financial stress facing many farmers.

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Debt-to-Asset Ratios of Ohio Farmers: A Polytomous Multivariate Logistic Regression of Associated Factors

Allan E. Lines and Carl R. Zulauf

Abstract

This paper describes an analysis of the relationship between debt-to-asset ratios and selected socioeconomic characteristics obtained from a sample of Ohio farm operators. The analysis was based on polytomous multivariate logit regression. A statistically significant relationship was found between debt-to-asset ratio and operator age, farm size, and percent of land farmed that was owned. No statistically significant relationship was found between debt-to-asset ratio and major source of farm income and off-farm income as a percent of family income.

Key words: debt-to-asset ratio, financial stress, farmers, farm sales, farmer age, owned land.

Since 1979, average debt-to-asset ratio on U.S. farms has increased from 17 percent (a level at which it had essentially remained for the preceeding 15 years) to an estimated 22 percent in 1984 (USDA, December 1984). The latter is the highest ratio since before 1940. Also since 1979, U.S. farm debt has increased by 53 percent, assets have increased by only 18 percent, and net cash income has declined by \$16.5 billion (USDA, December 1984). Farmers, thus, need to service considerably more debt with substantially fewer dollars. The result has been increasing numbers of farm bankruptcies, loan liquidations, and delinquent loans; in short, financial stress (USDA, 1985).

Several financial aid programs have been proposed to alleviate this stress (Swoboda; Sesker; Bullock; Harl; Boehlje; Paarlberg). These programs include the Reagan Administration's initiative, which has been implemented by USDA. Debate over this and other programs has been intense. A recent attempt by Congress to increase substantially the amount of federal aid available to farm operators was vetoed by President Reagan (Weintraub).

One reason for the continued debate is the lack of information concerning the magnitude, incidence, and extent of the financial stress problem. Recent studies have supplied some of this information. USDA has estimated that, on January 1, 1984, 363,000 farms (16.6 percent) were under some form of financial stress. Family-size commercial farmers (\$50,000-\$500,000 in sales) in financial stress numbered 178,000, 46 percent of the total. For south Georgia operators, Musser, White, and Smith found that as

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percent of land operated that was owned increased, debt-to-asset ratio decreased. Barlett, in a study of Dodge County, Georgia, farmers, found this same relationship as well as a positive relationship between debt-to-asset ratio and farm size and off-farm income. Jolly, in a study of Iowa farm operators, found that younger operators and operators of larger farms reported higher debt-to-asset ratio. Similar results were reported by both the Missouri and North Dakota Crop Reporting Services. In addition, USDA reported substantial variation in debt-to-asset ratios by farm types, with poultry and egg farmers being the most highly leveraged (1985).

While these studies have increased the understanding of the farm financial stress problem, each is essentially based on cross-tabulation of data by selected characteristics. Thus, their conclusions on the relationship between debt-to-asset ratios and farm characteristics have not been subjected to multivariate analysis. Ohio farm operators were randomly surveyed about their debt-to-asset ratios and selected other farm characteristics. Using the survey data, this study seeks to provide information about the farm financial stress problem by determining what, if any, of several common farm characteristics are statistically associated with farm operator's debt-to-asset ratio.

According to USDA's 1983 *State Income and Balance Sheet Statistics*, Ohio farm operators had an estimated debt-to-asset ratio of 18.9 percent on January 1, 1984. This ratio was smaller than the corresponding 21.6 percent average for the U.S., 26.1 percent average for Iowa, and 30.1 percent average for Nebraska. Thus, as a group, Ohio farmers are probably less stressed by debt than U.S. farmers in general and central plains state farmers in particular. Despite the lower debt stress, this study should provide insights into the extent and nature of the national farm financial stress problem.

The paper is organized as follows: (a) a conceptual discussion of debt-to-asset ratio as an indicator of farm financial stress; (b) a review of the Ohio farm operator survey and sample data; (c) a brief rationale for selecting logit regression as the analytical technique; (d) a description of the model

estimated; (e) a discussion of the empirical results; and (f) conclusions and implications.

Debt-to-Asset Ratios: A Conceptual Discussion

Although only one of several financial stress indicators, debt-to-asset ratio is frequently used to provide insight about farm financial stress. The validity of this ratio as a stress indicator arises from the fact that it measures the relative claim which debt has on the earnings generated by the farm's assets. The greater the debt, the greater the share of earnings (income minus cost of production excluding debt payment) generated by the assets which must be used to service debt. Hence, the greater the likelihood that earnings cannot cover production expenses, family living expenses, and debt payments. The result is cash flow problems and financial stress. Gabriel and Baker develop a conceptual framework that reveals the effects of leverage-induced changes in the variability of net cash flows resulting from fixed financial obligations associated with debt financing. Financial stress also depends on the cost of debt (interest rate) and the rate of earnings generated by the assets. The latter in particular has been shown to vary significantly with farm characteristics, most notably farm size. Large farms have higher rates of return on their assets (Melichar). Shepard and Collins, in their study of farm bankruptcies from 1910 to 1978, found a strong relationship between failure rates and leverage during the pre-World War II period; a period not unlike that of the 1980s when farm debt-to-asset ratios increased dramatically. Richardson and Condra demonstrate the critical importance of debt-to-asset ratio in determining the survivability of a farm business in the El Paso valley. In conclusion, although the context in which debt-to-asset ratio is being used should always be examined, it is a fairly reliable indicator of the potential for debt stress.

Survey

The data were generated by a random sample of 2,000 Ohio farm operators during March 1984. The sample was drawn from the universe of all Ohio farm operators, as identified by the Ohio Crop Reporting Service. One mailing resulted in 423 usable responses, a 21 percent response. As part of

a larger questionnaire, surveyed operators were asked to report their debt-to-asset ratio, age, number of acres farmed, percent of acres farmed which were owned, average annual gross farm sales in recent years, most important source of farm income in 1983, and percent of total family income that came from off-farm employment and investments in 1983. Except for percent of acres farmed which were owned, categorical data were collected. It was felt that, given the nature of the data being collected, asking for specific continuous data would result in a lower response rate.

Respondents mirrored the characteristics of Ohio farmers as reported in the 1982 *Agricultural Census*, with the exception that operators of large farms were over-represented. Average number of acres farmed by the respondents was 372, compared with 175 reported in the *Census*. Seventy-six percent of the respondents farmed less than 500 acres. Nearly half reported \$40,000 or less in gross farm sales while almost three-fourths reported \$100,000 or less in gross farm sales. Respondents were a mixture of crop, dairy, livestock, and other types of farmers. The distribution of respondents to debt-to-asset categories was: no debt, 42 percent; one to 25 percent debt-to-asset, 29 percent; 26 to 50 percent debt-to-asset, 16 percent; and 51 percent or greater debt-to-asset, 13 percent. On average, the respondents owned 64 percent of the land they operated. Forty-three percent of the respondents reported off-farm income was less than 25 percent of family income while 37 percent reported it was 50 percent or more.

Logit Regression

The object of this study is to determine what common farm characteristics are statistically associated with a farm operator's debt-to-asset ratio. Since debt-to-asset ratio was collected as an ordinal level categorical variable, the standard least-squares regression model (also called the linear probability model in this case) will have an error term which is heteroscedastic (Pendyck and Rubinfeld, p. 276; Johnston, p. 424). Weighted least-squares can be used to address this problem. However, not only is weighted least-squares sensitive to errors of specification, there is also no guarantee that

the predicted values for the dependent variable will lie within the range of the categorical values (Pendyck and Rubinfeld, p. 276; Johnston, p. 425). A constraint can be placed on the estimated value of the dependent variable, but there is no guarantee that the estimated parameters will be unbiased (Pendyck and Rubinfeld, p. 278). Thus, ordinary least-squares is not preferred on theoretical grounds. Furthermore, it has been shown to yield lower quality empirical results than alternative analytical techniques (for example, Debertin, Pagoulatos, and Smith; McKelvey and Zavoina).

Alternative analytical tools for models with qualitative dependent variables include linear discriminant analysis, probit, and logit. Maximum likelihood logistic regression, which is based on the cumulative logistic probability function, is preferred over discriminant analysis whenever one of the independent variables is qualitative (Halperin, Blackwelder, and Verter; Press and Wilson). This preference is in part based on the fact that linear discriminant analysis is strictly applicable only when the underlying variables are jointly normal with equal covariance matrices. In contrast, the logistic model results from a wide variety of underlying assumptions about the explanatory variables, including the case when some or all of the independent variables are dichotomous zero-one variables (Anderson, Halperin, et. al.) Furthermore, the discriminant function can yield a misleading result regarding the significance of a coefficient when the normality condition is violated (Press and Wilson, p. 701; and Halperin, et. al., p. 130).

Both the logit model and probit model, which are based on the cumulative normal probability function, have been used in the agricultural economics literature (for recent examples, see Chambers and Foster, probit; Garcia, et. al., logit; and Capps and Kramer, logit and probit). The logistic and probit formulations are quite similar, with the major difference being that the logistic has slightly more skewness toward the tails. The choice of technique (probit or logit) is somewhat arbitrary, as illustrated by the recent empirical analysis by Capp and Kramer. "... neither specification was judged superior. Hence, ... the differences in empirical performance between the

respective models were indeed minimal" (Capp and Kramer, p. 58). Logit regression was selected for this analysis of debt-to-asset ratio.

Model Estimated

The common farm characteristics hypothesized to be statistically significant discriminators of farm operators by debt-to-asset categories were gross farm sales, operator age, type of farm as defined by major source of farm income, percent of total family income that came from off-farm income, and percent of land operated that was owned. The specific logistic regression package chosen to conduct the analysis was LOGIST (Harrell; Walker and Duncan). The multinomial logit model estimated can be stated as follows:

$$\log (P_2/P_1) = \alpha_{21} + \sum_{j=1}^n \beta_{2j} X_{ji} \quad (1.1)$$

$$\log (P_3/P_1) = \alpha_{31} + \sum_{j=1}^n \beta_{3j} X_{ji} \quad (1.2)$$

$$\log (P_4/P_1) = \alpha_{41} + \sum_{j=1}^n \beta_{4j} X_{ji} \quad (1.3)$$

$$\log (P_3/P_2) = \alpha_{32} + \sum_{j=1}^n \beta_{3j+1} X_{ji} \quad (1.4)$$

$$\log (P_4/P_2) = \alpha_{42} + \sum_{j=1}^n \beta_{4j+1} X_{ji} \quad (1.5)$$

$$\log (P_4/P_3) = \alpha_{43} + \sum_{j=1}^n \beta_{4j+2} X_{ji} \quad (1.6)$$

where P_i is the relative probability of having a specified percent of debt, with the i categories given as:

- 1 = no debt,
- 2 = one to 25 percent debt,
- 3 = 26 to 50 percent debt, and
- 4 = 51 to 100 percent debt.

The independent variable vector X_i (i th producer) is comprised of the following variables:

X_{ji} = gross sales category of operator i
(excluded category is \$40,000 or less)

for $j = 1$ (1 if gross sales of \$40,001 to \$99,999, 0 if not)

for $j = 2$ (1 if gross sales of \$100,000 to \$199,999, 0 if not)

for $j = 3$ (1 if gross sales of \$200,000 or more, 0 if not)

X_{ji} = age category of operator i (excluded category is 65 or more years)

for $j = 4$ (1 if operator less than 35-years old, 0 if not)

for $j = 5$ (1 if operator 35 to 49 years old, 0 if not)

for $j = 6$ (1 if operator 50 to 64 years old, 0 if not)

X_{ji} = type of farm for operator i (excluded category is grain farm)

for $j = 7$ (1 if a livestock farm, 0 if not)

for $j = 8$ (1 if a dairy farm, 0 if not)

for $j = 9$ (1 if a 50/50 grain-livestock farm, 0 if not)

for $j = 10$ (1 if other type of farm, 0 if not)

X_{ji} = percent of total family living income coming from off-farm sources for operator i (excluded category is zero to 24 percent)

for $j = 11$ (1 if off-farm income was 25 to 49 percent of total family income, 0 if not)

for $j = 12$ (1 if off-farm income was 50 to 74 percent of total family income, 0 if not)

for $j = 13$ (1 if off-farm income was 75 to 100 percent of total family income, 0 if not)

X_{ji} = percent of land operated that is owned by operator i

Parameter estimates for equations 1.4 to 1.6 can be derived from the estimates for equations 1.1 to 1.3. For example,

$$\alpha_{32} = \alpha_{31} - \alpha_{21} \text{ and } \beta_{32} = \beta_{31} - \beta_{21}, \text{ etc.}$$

In this paper, we are only interested in estimating the parameter vectors for equations 1.1 to 1.3, the relative probabilities of carrying specific percentages of debt relative to no debt. The relative probability of any debt to no debt can be easily derived from these first three equations. Only the parameter estimates for equations 1.1 to 1.3 are presented. The reader can easily calculate those for equations 1.4 to 1.6.

The parameter estimates are obtained by solving the nonlinear maximum likelihood normal equations. While this is computationally more expensive than applying the linear probability least squares approach, the parameter estimates have more desirable properties. They are consistent, asymptotically efficient, and asymptotically normal. Individual parameters can be tested similar to the "t" test in regression, while statistical significance of the overall equation can be tested with the -2 log likelihood ratio.

The estimated parameters for gross farm sales and off-farm income were expected to be positive. The larger gross farm sales or off-farm income is, the greater the debt that can be accumulated, and, with a given asset base, the greater the debt-to-asset ratio becomes. Operator age was expected to be negatively related with debt-to-asset ratio. As a farmer approaches retirement, he is less likely to acquire new debt and more likely to retire existing debt. Thus, the debt-to-asset declines, a relationship consistent with Jolly's finding. Farmers who classify their main source of farm income as grains were expected to have higher debt-to-asset ratios. This expectation was based on the fact that grain farming is land intensive. Not only did land prices increase significantly during the 1970s but the need to maintain an adequate income pushed the grain farmer to acquire land. Lastly, the greater the share of land operated that was owned, the lower the debt-to-asset ratio was expected to be. Generally, the smaller the percent of land farmed that is owned, the smaller the amount of capital owned since land is the major capital input in farming. Consequently, a given level of

operating debt translates into a higher debt-to-asset ratio for smaller percentage of land operated that is owned.

Results

The estimated coefficients in table 1 must be interpreted with care. The left-hand sides of the equations in the logistic model are logarithms of the odds of being classified in a category, not the probability of being in the category. However, since a logarithm is a monotonic transformation, the logarithms of the odds reveals some characteristics of the underlying probability (Pendyck and Rubinfeld).

Table 1. Maximum Likelihood Estimates of Log Probabilities of Factors Associated with Debt-to-Asset Ratios of Farm Operators, Ohio, March 1984.

Variable ^a	Estimated Coefficients	Standard Error
Alpha		
21	0.83	.53
31	-2.57*	.54
41	-3.85*	.55
Gross Sales Variables		
\$40,001 to \$99,999	.82*	.31
\$100,000 to \$199,999	1.11*	.38
\$200,000 or more	2.03*	.47
Age Variables		
less than 35	2.30*	.53
35 to 49	2.33*	.46
50 to 64	1.46*	.44
Type of Farm Variables		
Livestock	-.21	.33
Dairy	.22	.33
50/50 Livestock-Grain	.27	.36
Other	-.06	.39
Off-Farm Income		
25% to 49%	.06	.36
50% to 74%	.05	.35
75% or more	.10	.34
Percent of Land Operated That Was Owned	-.01*	.003

Model R = .35^b

Model Chi-Square Statistic = 129, 14 d.f., p = 0.0

Source: Computations on original data.

^aFor a discussion of the variables, see the text.

^bMeasure of fit, ranging between 0 and 1

*Significant at the one percent level of confidence

For the dummy variables, the coefficients are the change in the logarithms of the odds of

being classified in a higher debt-to-asset category because the operator has a given attribute instead of the attribute used to create the dummy variable. For example, having gross sales between \$40,001 and \$99,999 instead of less than \$40,001, results in a higher logarithm of the odds, therefore probability, of being in a higher debt-to-asset ratio category.

Each of the gross sales and age dummy variables were significantly different from zero at the one percent level of significance. The coefficient also had the hypothesized sign. The test for significance was based on the Wald statistic, a maximum likelihood chi-square statistic. It is calculated by dividing the estimated parameter by its standard error and squaring the result (Harrell, p. 182.)

As gross sales increased, the coefficient on its associated dummy variable was significantly more positive at the one percent level of significance than the coefficient on the next smaller gross sales category. This finding supports the cross tab analyses which have found that larger farms have higher debt-to-asset ratios than smaller farms (USDA, 1979 and December 1984; Melichar; Barlett; Jolly).

Turning to the age variables, the findings support the commonly held opinion that younger farm operators have higher debt-to-asset ratios (age was dummied on the oldest group, 65 or more). Again, a similar relationship has been reported by others, but their findings have been based on cross-tab analyses (USDA, 1979; Jolly). Note that the coefficient for the two youngest age group dummy variables are almost identical. Thus, compared with farm operators 65 or older, operators less than 35 are not more likely to be in a higher debt-to-asset category than are operators between 35 and 49-years old. This finding does not support the perception that young operators are more likely to have higher debt-to-asset ratios than their middle age counterparts. The data does, however, indicate that operators less than 50-years old are more likely to fall in the next higher debt-to-asset category than those in the 50 to 64 age group.

In contrast to the coefficients for gross farm sales and age variables, the coefficients for percent of total income earned off the farm

and type of farm variables were not statistically different from zero. Thus, grain farmers and farmers who earn most of their family's income off the farm did not have higher probabilities of having higher debt-to-asset ratios. These findings fail to substantiate Barlett's or Gladwin and Zabawa's findings that part-time operators (i.e., higher percent of family income from off-farm income), on average, carry lower debt-to-asset ratios than full-time farmers or USDA's finding that debt-to-asset ratios vary significantly by farm type. Again, their conclusions were based on cross-tab analysis and thus not subject to multivariate analysis.

The percent of land owned coefficient is significantly different than zero at the one percent level of significance. For a one percent increase in the percent of land farmed that was owned, the logarithm of the odds that an operator will be in the next higher debt-to-asset ratio category decreases by .01. This finding is consistent with Barlett's finding that tenants were more highly leveraged than either full or partial owners.

Lastly, the estimated logistic multiple regression model had a likelihood ratio chi-square of 129 which was significantly different from zero at the one percent level of significance. The model explained 35 percent of the log likelihood variation. This value is analogous to the squared multiple correlation coefficient in the standard regression setting. While the value is low, it is not unreasonably low for cross-sectional categorical data. Also, the model correctly classified 76 percent of the observations in their observed categories.

Summary and Conclusions

This analysis accomplished three things: it provided empirical support for utilizing polytomous multivariate logit regression as an analytical tool for problems of the type investigated; it identified three independent variables that were statistically significant discriminators of Ohio farm operators' debt-to-asset ratios (gross farm sales, operator's age, and percent of land farmed that was owned); and it identified two independent variables that were not statistically significant discriminators of Ohio farm operators' debt-

to-asset ratios (major source of farm income and percent of family income coming from off-farm sources).

These findings suggest that in Ohio, financial stress, as indicated by debt-to-asset ratio, is widespread across farm types and degree of farm family dependence of off-farm income. Also, middle aged Ohio farm operators appear to be experiencing as much financial stress as their younger counterparts. Therefore, relief targeted at full-time Ohio farmers or grain farmers (or some other type) or young, recent entrant farmers may address only part of the problem. In contrast, a broad spectrum approach is suggested by this analysis which probably means that the cost of a relief package will be high and involve significant slippage in that farmers who do not need help will likely qualify for the aid.

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Interest Rate Deregulation and Agricultural Banking: A Risk Programming Analysis

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Abstract

The impact of deposit interest rate deregulation on small agricultural banks is analyzed using a quadratic programming model that incorporates both risk and market imperfection. The model was used to generate risk efficient bank portfolios before, during, and after deregulation. Parameter variations were used to analyze portfolio adjustments resulting from improved matching of liabilities with nonloan assets, adoption of floating loan rates, and increased interest rates on loans. To cope with the riskier environment, agricultural banks must either accept greater portfolio risks, adopt more conservative portfolios, or more vigorously manage interest rate risks.

Key words: agricultural banking, interest rate deregulation, risk analysis, quadratic programming

The current era of regulatory change in U.S. financial markets is strongly influencing the cost and availability of loan funds for agricultural borrowers through its impacts on smaller rural banks. Interest rates are higher and more volatile than in the past, and have contributed to financial stress conditions for many farms and banks alike. Developing managerial strategies to cope with these conditions is an important task.

The major regulatory issues in financial markets have involved: (a) price controls for loans and deposits; (b) reserve requirements; (c) the structure and geographic scope of banking; and (d) the types of products and services that depository institutions may offer. In the early 1980s most of the emphasis was on the removal of interest rate ceilings on deposits, traditionally called Regulation Q (Winningham and Hagan). Legislation authorizing these changes is found in the Depository Institutions Deregulation and Monetary Control Act of 1980 and the Depository Institutions Act of 1982 (Federal Reserve Bank of Chicago, 1981, 1983). Changes in structural and product regulations are under consideration for the future.

Price deregulation was intended to improve the competitive position of banks in the savings market, to alleviate disintermediation pressures, and to offer more equitable investment opportunities to small savers. These changes were expected to impact heavily on smaller banks that had experienced greater funding problems and less flexible balance sheet management than larger banks (Barry, 1984). Although smaller banks have improved their access to

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loanable funds, they have also experienced higher, more variable costs of funds that add to banking risks and encourage more comprehensive management of rate-sensitive assets and liabilities.

In this article, portfolio theory under risk and imperfect loan markets is used to evaluate the impacts of interest rate deregulation on agricultural banks. A risk programming model of a small rural bank is developed to reflect the financial market environment before, during, and after price deregulation, and to evaluate the effects of various alternatives in asset/liability management and loan pricing on the risk, return, and composition of the bank's portfolio. Especially important are the stabilizing effects of management policies that increase the correlation between the bank's cost of funds and return on assets. The implications of the results are then considered in terms of actual bank performance, agricultural lending, and future regulatory changes.

Analytical Framework and Related Studies

The analytical framework relevant here is based on the joint effects of market structure and risk on the composition and scale of a bank's portfolio. Relatively few empirical studies have considered these joint effects, although developments in banking theory have brought them into the analytical framework (Baltensperger). As shown by Shull and Mason, a bank's asset choices generally are characterized by nearly perfect competition for securities, but imperfect competition in lending with the imperfections increasing in smaller banking markets that are farther removed from metropolitan areas (Barry, 1978). Under these conditions, the exogenous yield on securities combines with loan demand characteristics to influence a bank's pricing and portfolio policies; moreover, banks can consider segmenting their lending markets along competitive lines and pricing loans accordingly.

Under uncertainty, the investment (or default) risk from fluctuations in returns on bank assets and the interest rate risk from unanticipated changes in costs of funds likely have the greatest impacts on portfolio management (Barry, 1984). These risks

combine with the above market characteristics to explain banks' diversification among assets and liabilities, reserves, leverage positions, and other risk responses. Several studies have used mean-variance analysis to evaluate risk-efficient bank portfolios in which risks are expressed by variances and covariances for returns on assets and costs of funds (Baltensperger; Robison and Barry; Tauer and Boehlje). However, these studies have assumed that all of the bank's assets and liabilities are acquired in perfectly elastic markets.

Klein and James combined the risk and market structure phenomena to show the theoretical implications for mean-variance efficient sets of holding assets characterized by downward sloping demand curves. In addition, Dixon and Barry extended the Klein-James framework to include the effects of estimation risk when the moments of the distribution of asset returns are unknown. They also considered the modeling implications of risk and market imperfections, and used a simplified banking situation to show that the portfolio effects of risk and market imperfections are not trivial.

Modeling Approach

The modeling approach followed here first specifies a small rural bank's financial environment and decision setting in a static mathematical programming model, generates a set of risk efficient bank portfolios, and finally analyzes various portfolio adjustments based on parameter variations for selected model solutions (Robison and Barry). These procedures are followed for three time points that represent the rural banking environment before, during, and after price deregulation. Time point one (TP1) represents the pre-deregulation conditions of the mid-1970s when the cost of funds and loan rates for rural banks in general were relatively stable and insulated from national market conditions. Time point two (TP2) represents an interim period prior to the 1980 act, characterized by higher, more volatile interest rates and by regulatory authorizations for banks to offer six-month money market certificates (MMC) and 30-month certificates of deposit (CD), both having rate ceilings indexed to the yields on U.S. government securities. Time point three (TP3) represents anticipated conditions for the postderegulation period.

For each time point, a set of risk-efficient portfolios is generated and then a base solution is selected for equilibrium analysis using a stipulated trade-off (λ) between risk and return in the model solution. Several values of λ are used since the risk-efficient sets shift significantly over the time points toward higher values of risk and returns. In general, the decision choices available in each base solution represent the methods of fixed-rate pricing and asset/liability management followed prior to deregulation. The equilibrium analysis introduces several managerial responses to a riskier, more competitive banking environment to evaluate their effects on the bank's portfolio. These responses include: (a) improved matching of liabilities with nonloan assets; (b) adoption of floating loan rates; and (c) increased interest rates on loans in conjunction with floating loan rates.¹

General Model Specifications

The general characteristics of the bank model are summarized in table 1, under the assumptions that probability distributions are fully characterized by means and variances and that the imperfect loan assets have linear demand functions (Barnard). The objective function represents a trade-off between the bank's expected after-tax returns and variance of returns with risks represented by variances and covariances among the asset and liability activities.

The basic form of the objective function follows the specifications of the Rand quadratic program in which the objective is to minimize

$$\lambda CX + X'QX$$

where the X s are the activity levels, C is a matrix of after-tax net income levels for the bank at various tax rates, Q is the variance-covariance matrix, and λ is interpreted as the slope coefficient for the risk efficient set. Minimization requires that the C values are entered with negative signs and, since λ is multiplied by the linear portion, then higher values of λ represent lower levels of risk aversion.

¹Other parameter variations not reported here include the effects of changes in costs of funds, reserve requirements, deposit feedback, and elasticity of loan demand. These results are reported in Barnard.

For each time point the acquisitions of assets and liabilities are constrained by limits on various sources of funds, capital requirements, and accounting specifications. The bank's decision variables include investments in agricultural and non-agricultural loans, purchasing taxable and nontaxable securities, acquiring funds from deposit and nondeposit sources, and paying taxes and dividends. The limit on allocable funds is the same at each time point; however, the specific data, activities, and constraints are tailored to each period's characteristics. The following discussion reviews the TP1 model in detail, and then indicates the primary changes for the TP2 and TP3 conditions.

Expected net yields for nonloan assets (federal funds, treasury securities, nontaxable securities) are the differences between mean values of weekly rates reported in the *Federal Reserve Bulletin* for the corresponding time period (1977 for TP1 and 1980 for TP2 and TP3) and operating expenses reported in the Federal Reserve's *Functional Cost Analysis* (FCA) for banks with less than \$50 million in total deposits. Expected loan yields were found by partially solving an estimated loan demand equation (see the following section) and collecting the effects of the independent variables in the intercept term. Average default rates and operating expenses are then deducted from the intercept value to give a net loan yield, exclusive of the additional deposits fed back to the bank from its lending activities.²

The deposit feedback effect was specified as a reduction in the amount of allocable funds needed to acquire loans, thus increasing the effective loan yield. The deposit feedback rates for agricultural loans in TP1 and TP2 were specified as 28.8 percent, based on results of an earlier study by Barry (1978); a lower feedback of 25 percent for non-agricultural loans reflected greater sources for these loans in rural markets. These rates were reduced to 18.8 percent and 15 percent, respectively, in TP3 to reflect a greater emphasis on interest rates in loan pricing

²Data on operating expenses and default rates for agricultural loans came from the commercial and agricultural loan category of FCA reports for 1977 and 1980. Comparable data for nonagricultural loans were estimated as a weighted average of real estate and installment loan categories from the same source.

Table 1. Outline of Bank Model

Constraint	ASSETS			LIABILITIES			ACCOUNTING			Relation	Level
	Agr. Loan	Non-Agr. Loan	Taxable Securities	Nontaxable Securities	Deposits	Borrow	Net Income	Taxes & Dividend	Ending Cash		
	1	2	3	4	5	6	7	8	9		
Objective							C	-C ₁			Max
Deposits					a						B
Borrow						a					B
Allocable Funds	a_1	a_1	a	a	-a ₁	-a					0
Ending Cash	-a	-a	-a	-a	a	a		a	a		0
Capital Req.	a	a	a	a							0
Income, Taxes, & Div.	-a	-a	-a	-a	a	a	a	a			B
											0
<i>Variance—Covariance</i>											
Agr. Loan	σ_1^2										
Non-Agr. Loan	σ_{21}	σ_2^2									
Tax Securities	σ_{31}	σ_{32}	σ_3^2								
NonTax Securities	σ_{41}	σ_{42}	σ_{43}	σ_4^2							
Deposits	$-\sigma_{51}$	$-\sigma_{52}$	$-\sigma_{53}$	$-\sigma_{54}$	σ_5^2						
Borrow	$-\sigma_{61}$	$-\sigma_{62}$	$-\sigma_{63}$	$-\sigma_{64}$	σ_{65}	σ_6^2					

relative to the traditional deposit relationship (Barnard).

The costs of acquiring allocable funds are based on similar procedures. Expected costs for federal funds, large CDs, and Federal Reserve borrowing are the sum of mean values for their respective weekly interest rates, as reported in the *Federal Reserve Bulletin* for the corresponding time period, plus noninterest costs for these activities as reported in the FCA. Interest and noninterest costs (net of fees or service charges) for demand deposits, savings deposits, and time deposits came from the FCA reports.

The remaining activities allow for the transfer of net income to the objective function and for paying dividends and taxes. Since asset sales prior to maturity are not allowed, no provision occurs for capital gains taxes.

These decision variables are constrained by limits on various sources of funds and by obligations on legal reserves, capital requirements, taxation, and dividends. The model bank's initial capital structure was based on the average portfolio of 67 small rural banks in central Illinois for 1977 (Barnard). For TP1, total assets were limited to \$14.81 million based on \$1.01 million of equity capital and \$13.80 million of liabilities comprised of demand deposits (\$5 million), savings deposits (\$3 million), time deposits (\$5 million), large CDs (\$6 million), federal funds (\$.1 million), and Federal Reserve borrowing (\$.1 million).

Reserve requirements were modeled as a reduction in allocable funds for the various deposits. Capital adequacy is based on a capital-to-total asset ratio of .08, so that each dollar of asset acquisition depletes \$.08 of equity. The initial equity of \$1.01 million roughly equals the bank's investments in buildings and other fixed assets, neither of which are included in the model. Interest income, expenses, and other transactions occur at the end of the model period. Any excess income is transferred to an ending cash activity that measures net earnings after taxes and dividends.

The TP2 and TP3 models are similar to TP1, although the data and some other specifications are adapted to the changing financial market conditions. The major

changes in TP2 are the use of 1980 data for costs, returns, and tax rates, increased equity capital of about 30 percent, and allowing acquisition of six-month MMCs and 30-month CDs.³ The asset choices were the same as in TP1.

The TP3 model was intended to represent the financial environment after price deregulation is completed. When the model was formulated, little was known about deposits and other funding sources that would occur in a deregulated environment. However, it was anticipated that deposit classes would have narrower rate spreads between them with greater tailoring of maturities and other terms to the preferences of depositors. In this light, the banks' sources of funds included: federal funds (\$.1 million), transactions accounts (\$6.7 million—the sum of demand and savings accounts in TP2), four classes of time deposits (\$6.8 million), Federal Reserve borrowing (\$.1 million), and Federal Intermediate Credit Bank (FICB) borrowing (\$.1 million).⁴ The four time deposits represent deposit instruments of different maturities (90-day, 180-day, 12-month, 30-month) that coincide with the maturities of several U.S. Treasury bills and bonds.

Mean values of interest costs (except for FICB borrowing) are based on adjustments from the rate on 30-month CDs in TP2. The rate differentials for the other three time classes were based on average differences between mean annual rates for the respective U.S. Treasury securities over the 1975–1978 period. The rates for transaction accounts and fed funds were both .25 percent less than the 90-day rate. The FICB rate was the sum of the average rate for 180-day Treasury bills in 1980 plus a .4 percent spread for Farm Credit bonds plus a .2 percent FICB operating spread.

Asset activities in TP3 were the same as TP2, as were the expected yields for nonloan assets. However, the intercept values of the

³Limits on the \$13.8 million of allocable funds were as follows: federal funds, \$.1 million; demand deposits, \$.4 million; savings deposits, \$.27 million; time deposits, \$.17 million; large CDs, \$.12 million; Federal Reserve borrowing, \$.1 million; MMCs, \$.35 million; and 30-month CDs, \$.5 million.

⁴FICB borrowing was included in response to the Farm Credit Act Amendments of 1980 that expanded the access of agricultural banks to this funding source.

loan demand functions were increased to reflect the 1980 average rate on farm operating loans from agricultural banks in the Chicago Federal Reserve District. These intercept values then were adjusted to net values based on 1980 loan expenses, loss rates, and the reduced deposit feedback. Other TP3 specifications were the same as TP2.

Risk and Imperfect Market Specifications

The objective function for the bank model is formulated to yield a minimum variance-efficient set of bank portfolios for different levels of expected net income, where investment in loans is characterized by downward sloping demand curves. As Dixon and Barry have shown, under an assumption of linear uncertain demand, these conditions yield a portfolio model that is solved by quartic programming. If, however, the slope of the return function for loans is deterministic, as occurs here, then the model is solved by quadratic programming. Thus, the data required for the objective function include variances and covariances for rates of return on assets and costs of liabilities, and an estimated demand function for loans.

The variances and covariances among the liabilities and the perfectly elastic assets were calculated from the same data series used to estimate mean values for these activities in each TP model. The TP2 model had greater variability in rates and more sources of funds that were rate sensitive than in TP1. The same levels of variances were used in TP3 as in TP2, although all funding sources in TP3 were rate sensitive. Thus, TP3 had the greatest variability of the three models.

The covariances between assets and liabilities could not all be measured from a common data base due to differences in data availability for loan rates and to the estimation procedure for the loan demand function. Thus, a judgmental approach was followed in initially specifying correlation coefficients of .5 between the return on nonloan assets and costs of liabilities and .2 between the returns on loans and costs of liabilities. These moderate levels of positive correlation reflect a general tendency for interest rates to move together, although the loan rates are assumed to adjust more sluggishly. More rigorous management of

assets and liabilities, as is evaluated below, would yield higher correlations. Covariances between assets and liabilities were then determined as the product of the correlation coefficient and the respective standard deviations for assets and liabilities. These positive covariances were entered into the quadratic program with negative signs to reflect their stabilizing effects.

The yield relationship for loans was based on a linear demand function for nonreal estate farm loans estimated by Barnard. The loan rate was specified as a function of loan volume and seven other exogenous variables; it was estimated from annual bank and market data for the 67 banks, cited earlier, over the 1973 to 1979 period.⁵ For use in the risk program, the intercept term of the loan demand function was adjusted to reflect the products of the mean values of the other exogenous variables times their respective coefficients. This gave the expression $P_l = A - \beta X_l$ where P_l is the loan rate and X_l is loan volume. The same demand function was used for nonagricultural loans in each model, except that the slope coefficient was reduced by 50 percent to represent different competitive characteristics.

Using least squares estimation introduces estimation as well as market risk in the estimated loan demand function (Klein and Bawa; Dixon and Barry). Consequently, cubic and quartic terms occur in the model's objective function, unless the slope coefficient for the loan demand function is assumed deterministic. This assumption seemed reasonable here since interest rate deregulation alone did not appear to alter the degrees of market concentration in banking.⁶ To include both estimation and market risk, the equation for the loan demand function was solved by substituting values for all independent values except loan volume (see above). The effect of this procedure on

⁵The estimated loan demand function was $P_l = 8.024 - .076X_l$, after adjusting the intercept term to account for variables representing farm income, PCA loan rates, price support loan volume, bank competitors, inflation, and the exogenous securities rate. The results indicated a highly elastic function with four of the variables significant at the five percent level.

⁶This assumption may not hold in the future as savings and loan associations acquire more liberal asset authorities and as geographic restrictions on banking are liberalized.

estimation variance is accounted for by pre- and postmultiplying the variance-covariance matrix of the estimated coefficients by the mean value of the independent variables. Since the slope, β , is deterministic, then

$\frac{\partial}{\partial \beta}$ and $\frac{\partial}{\partial A}$ equal zero and only the variance of the intercept, A , appears in the matrix.

Besides uncertainty about the unknown parameters, market risk must also be included. This occurs by combining the

estimation risk ($\frac{\partial}{\partial A}$) for A (intercept term) and market risk for loans into one term. Moreover since the slope term (β) is multiplied by a squared term in the objective function, it is also added to market and estimation variance in order to collect all squared terms into a single term (γ). Thus, the following variance specifications were used for the two loan categories:

	Agr Loans (γ)	Non-Agr Loans (γ)
Forecast variance	5.31298	5.31298
Estimation variance	51.51262	51.51262
Slope coefficient	0.00075	0.00038
Total	56.82635	56.82598

To calculate covariances between loan yields and cost of liabilities, the standard deviation of the intercept (A) is measured as the square root of the sum of the variances for market and estimation error. The covariances in the base models were then the products of this standard deviation, the standard deviations for the cost coefficients, and the specified correlation coefficient of .2.

Model Results

The major focus of the model results is on the portfolio effects at each time period of parameter variations that represent managerial responses to the more volatile interest rate conditions of deregulation. However, it is helpful to briefly characterize the full set of risk-efficient solutions for each time point. Theoretically, one would expect an infinite number of trade-off values between risk and returns, with the bank's

portfolio showing increased specialization in assets and funds acquisition as well as a larger scale of operations for higher risk-return solutions along the risk-efficient set. This indeed occurred, except a finite number of solutions resulted, due to a solution being identified with each change in the basis. The TP1 model had 19 risk-efficient solutions characterized by increasing levels of funds acquisition for the first 14 solutions, with a shift toward higher cost, higher risk sources until the funding limits were reached. Similarly, the allocation of funds in TP1 among the risky assets showed greater specialization among lending and investments for higher risk-return solutions. The income maximizing solution specialized in two activities (nontaxable securities and agricultural loans) due to their differing elasticities.

Similar solution patterns occurred in the models for TP2 (28 solutions) and TP3 (25 solutions). In addition, the risk-efficient sets for TP1 and TP2 intersected so that TP2 had greater risk efficiency for the higher risk-return solutions due mostly to the stabilizing effects of the positive covariances between the asset returns and the costs of rate-sensitive liabilities. In contrast, however, the risk-efficient set for TP3 shifted strongly toward higher variances for each expected value of the objective function and became much steeper due to the sharp increases in variance for the higher return solutions. These changes clearly reflected the additional rate-sensitive funding sources in the TP3 environment.

The selection of the risk-return trade-off value (λ) for equilibrium analysis was intended to provide consistency over the three time points. However, the wide range of λ values that occurred in each model precluded selecting a single value. For example, the middle value of λ (14,310) in the TP1 solutions was extremely low for the TP3 model. Similarly the middle value of λ in TP3 (294,976) was nearly the maximum value for TP2. Thus these two levels of λ were selected for equilibrium analysis in order to link together all three models and to use the middle values for TP1 and TP3. Both values were used in TP2 to represent two levels of λ during the transition period represented by TP2. The values selected are: $\lambda=14,310$ for TP1; $\lambda=14,310$ and $\lambda=294,976$ for TP2; and

$\lambda=294,976$ for TP3. This compares the TP1 and TP2 results, and the TP2 and TP3 results, and thus roughly links the three periods.

Coordinating Nonloan Assets and Liabilities

From a bank's standpoint an improved coordination of nonloan assets and liabilities involves a closer matching of the maturities, rate patterns, and other characteristics for its securities and funds acquisition activities. This coordination is modeled by an increase in the correlation coefficient on nonloan returns and costs of rate-sensitive liabilities from the base value of .5 to an adjusted value of .8. This change should shift the risk-efficient solution toward greater risk efficiency and relatively greater holdings of nonloan assets, especially in the more volatile time periods, since these acquisitions would slow the rate of increase (or decrease) in portfolio risk as expected returns increase. The model solutions in general are consistent with these anticipated responses.

As shown in table 2, the stronger correlation between nonloan assets and liabilities has very little effect on portfolio composition in TP1 since few of the liabilities are rate-sensitive. The responses are stronger, however, in TP2 and TP3. As shown in tables 2 and 3 for the two levels of λ in TP2, the increase in correlation enables a greater scale of bank operation, higher expected income, reduced portfolio variance, relatively greater holdings of nonloan assets (primarily fed funds), and a minor reduction in loans relative to total assets, although absolute loan volume increased. These responses were relatively greater for the lower (more conservative) value of λ . The greater scale of operations was funded by additional time deposits and CDs since these sources had not reached limiting levels.

The TP3 solutions in table 3 indicate a similar pattern of response, although the magnitudes are greater, perhaps due to the smaller scale of operations in the base solution. Recall that $\lambda=294,976$ was a moderate level in TP3 and a much more liberal value in TP2. Implementing this scenario in TP3 resulted in an increased bank size by about 65 percent, higher expected income (31 percent), and higher portfolio variance (28 percent). Thus, variance relative to expected income

declined. The higher risk efficiency mainly reflects a decline in the proportion of total loans to total assets from 81.2 percent to 49.2 percent. In general, these results show that the bank's performance will benefit from stronger coordination between nonloan assets and liabilities, although the relative importance of lending may decline.

Variable Rate Loan Pricing

The second type of equilibrium analysis involves the bank's portfolio responses to the formal adoption of variable loan rates. Similar to the coordination of nonloan assets and liabilities, variable rates represent a bank's attempt to stabilize its performance by achieving a higher correlation between the returns from lending and the costs of funds. Hence, variable rates are modeled by increasing the correlation coefficient between lending and funding from .2 in the base model to .5 in the variable rate scenario. In concept, variable rates might be perfectly positively correlated with costs of liabilities in order to completely remove interest rate risk; however, an increase in the correlation to a moderately high level of .5 seemed appropriate since banks seldom can reprice loans with the same frequency and precision as funding costs change (Barry and Calvert).

As with the preceding scenario, variable rates should reduce interest rate risks from lending and allow greater lending especially in the more volatile time periods. Offsetting effects may arise from a larger scale of operations and funding from sources with higher costs and variances. As table 2 indicates, the variable rate solution for TP1 compared to the base indicates a larger scale of operation (6.8 percent), moderate increases in lending (8.4 percent), higher expected income (2.5 percent), and a moderate increase in portfolio variance (eight percent). The responses are stronger for the same λ value in the more volatile TP2 model in which increases occur in total assets (34 percent), expected income (seven percent), and total lending (52 percent), while portfolio variance declines by 35 percent. A similar yet weaker response to variable rates occurred in TP2 as the λ value increased to 294,976, reflecting lower risk aversion. As table 3 shows, the variable rate scenario has greater lending and total assets, and reductions in expected income and variance. The stronger

Table 2. Results for the Base and Alternative Scenario Runs, TP1 and TP2 Models.¹

	TP1 Model					TP2 Model				
	Base	Increase A/L Mgt.	Var. Rate Loan Price	Increase Loan Rate	Base	Increase A/L Mgt.	Var. Rate Loan Price	Increase Loan Rate	Base	Increase A/L Mgt.
Assets:										
Expected Income	14,310	14,310	14,310	14,310	14,310	14,310	14,310	14,310	14,310	14,310
Quadratic X 10 ⁶	151,003	150,408	154,690	197,745	194,016	206,028	207,639	350,627	350,627	350,627
Quad. ÷ Exp. Inc.	427	423	394	732	737	410	480	1,223	1,223	1,223
	2,830	2,813	2,545	3,702	3,800	1,989	2,310	3,488	3,488	3,488
Fed. Funds Sold	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)
1-Year T-Bills	132	1.5	0.7	3.1	0	796	8.6	2.3	0	0.0
Nontax. Sec.	0	0.0	0	0	0	6	0.1	0	0	0.0
Agr. Loans	3,911	47.5	48.3	4,007	2,834	3,314	35.7	2,904	30.3	30.5
Non-Agr. Loans	1,948	23.7	23.8	2,092	2,001	2,387	25.7	2,979	31.1	30.28
Reserves	1,729	21.0	690	20.9	1,893	21.5	2,359	24.5	2,963	31.0
Total Assets	516	6.3	533	6.1	426	6.0	497	5.4	504	5.3
	8,236	100.0	8,890	100.0	7,163	100.0	9,574	100.0	9,278	100.0
Liabilities:										
Fed. Funds Pur.	100	1.2	100	1.1	0	0	0	0	0	0.0
Demand Dep.	5,000	60.7	5,000	56.8	4,000	43.2	4,000	41.8	4,000	43.1
Savings Dep.	2,825	34.3	2,868	34.1	2,700	37.7	2,700	28.2	2,700	29.1
Time Dep.	0	0.0	0	0.0	0	984	10.7	1,700	17.8	18.3
1-Year CD	211	2.6	0	6.8	385	5.4	1,200	12.9	928	9.7
6-Month CD	N/A	N/A	N/A	N/A	0	0	0	0	0	0.0
30-Month CD	N/A	N/A	N/A	N/A	0	0	0	0	0	0.0
Fed. Res. Borrow.	100	1.2	100	1.1	78	1.1	100	1.0	100	1.1
Total Liabilities	8,236	100.0	8,890	100.0	7,163	100.0	9,574	100.0	9,278	100.0

¹The first column for assets and liabilities of each scenario is in \$1,000 units and the second column is the percentage of total assets and total liabilities.

Table 3. Results for the Base and Alternative Scenario Runs, TP2 and TP3 Models.¹

	TP2 Model				TP3 Model			
	Base	Increase A/L Mgt.	Var. Rate Loan Price	Increased Loan Rate	Base	Increase A/L Mgt.	Var. Rate Loan Price	Increased Loan Rate
A	294,976	294,976	294,976	294,976	294,976	294,976	294,976	294,976
Expected Income	229,831	234,009	229,368	385,600	46,264	60,791	52,976	113,665
Quadratic X 10 ⁶	5,713	5,167	5,346	10,356	-4,910	6,303	5,615	13,524
Quad. ÷ Exp. Inc.	24,858	22,079	23,308	26,857	106,129	103,682	106,915	118,981
Assets:	(\$1,000)	(%)	(\$1,000)	(%)	(\$1,000)	(%)	(\$1,000)	(%)
Fed. Funds Sold	1,454	16.7	2,251	23.4	594	14.7	2,459	43.3
1-Year T-Bills	0	0.0	0	0.0	0	0.0	0	0.0
Non-tax. Sec.	3,449	39.8	3,521	36.7	94	2.7	343	6.0
Agri. Loans	2,096	24.2	2,109	22.0	1,397	40.6	1,408	24.8
Non-Agr. Loans	1,202	13.9	1,209	12.6	1,395	40.6	1,294	24.5
Reserves	473	5.4	510	5.3	50	1.4	82	1.4
Total Assets	8,674	100.0	9,600	100.0	3,440	100.0	5,686	100.0
Liabilities:								
Fed. Funds Pur.	0	0.0	0	0.0	0	0.0	0	0.0
Demand Dep.	4,000	46.1	4,000	41.7	0	0.0	0	0.0
Savings Dep.	2,700	31.1	2,700	28.1	0	0.0	0	0.0
Time Dep.	1,700	19.6	1,700	17.7	0	0.0	0	0.0
1-Year CD	274	3.2	1,200	12.5	1,640	47.7	1,700	29.9
6-Month CD	0	0.0	0	0.0	1,700	49.4	1,700	29.9
30-Month CD	0	0.0	0	0.0	100	2.9	100	1.8
Fed. Res. Borrow.	0	0.0	0	0.0	0	0.0	0	0.0
Total Liabilities	8,674	100.0	9,600	100.0	3,440	100.0	5,686	100.0

¹The first column for assets and liabilities of each scenario is in \$1,000 units and the second column is the percentage of total assets and total liabilities.

variance decline indicates a gain in risk efficiency.

The TP3 responses to variable rates were weaker overall, although the high λ value in TP3 yields a much more conservative portfolio than in TP2. As table 3 shows, the variable rate scenario yields about the same increases in expected income (14 percent) and variance (14 percent), and moderate increases in total lending (19 percent) and total assets (16 percent). These TP3 responses were more moderate than in the previous scenario despite the same increase in correlation between nonloan assets and funding. The more moderate responses may reflect the dampening effects of the downward sloping loan demand curves, and the effects of individual variances.

Increased Loan Interest Rates

The third type of equilibrium analysis involves the bank's portfolio responses to raising its loan rates in order to offset the increased interest rate risk involved with lending. Variable rate loan pricing is also included in this scenario, since the two responses would likely occur together. Increased interest rates on loans are modeled by increasing the intercept term of the estimated demand equation to reflect the average rate charged for operating loans in the Chicago Federal Reserve District in 1977 and 1980 for TP1 and TP2, with the TP2 rate also used in TP3.

Increased loan rates should increase the risk efficiency of lending, and thus allow greater lending and a larger scale of operations. Offsetting effects on income may arise from the larger scale of operation and funding from sources with higher costs and variances. As table 2 indicates, the increased loan rate solution for TP1 compared to the base has a larger scale of operation (34.3 percent), greater lending (33.5 percent), higher expected income (31 percent), and a greater increase in portfolio variance (71.4 percent). The responses for the same λ value in the more volatile TP2 model indicate an increase in total assets (29.5 percent), but stronger increases in total lending (52.7 percent), portfolio variance (65.9 percent), and expected income (80.7 percent). A similar response to increased loan rates occurred in TP2 as the λ value increased to 294,976. As

table 3 shows, the increased loan rate scenario has slightly greater total assets (28.4 percent), moderate increases in expected income (67.8 percent) and portfolio variance (81.3 percent), and a much greater increase in total lending (152.9 percent). Along with a slight decrease in nontaxable securities (3.5 percent), these results reflect a shift to the more risk-efficient loans.

The TP3 responses to higher loan rates were weaker in terms of total operations and lending, although the high λ value in TP3 yields a much more conservative portfolio than in TP2. However, the responses are much stronger for expected income and portfolio variance. As table 3 shows, the increased loan rates yield an increase in total assets (39.9 percent), a moderate increase in total lending (69.6 percent), and much greater increases in expected income (145.7 percent) and portfolio variance (175.4 percent). The strong responses for expected income and portfolio variance may reflect the increasing importance of customer loan pricing and profitability in a more volatile interest rate environment.

Implications and Concluding Comments

The relative changes in the risk-efficient sets evaluated here clearly demonstrate how interest rate deregulation is affecting the risk position of small rural banks. To cope with a riskier environment, these banks must either accept the greater portfolio risks, adopt more conservative portfolios, or more rigorously manage interest rate risks. The management methods evaluated here included (a) stronger coordination between nonloan activities and funds acquisition, (b) variable rate pricing, and (c) increased interest rates on loans. The model results indicated that each method can contribute effectively to the portfolio adjustment process with the effects increasing as the volatilities from deregulation increase. Thus, those smaller banks that adopt one or more of these methods (and perhaps other methods) should exhibit stronger lending performance for their agricultural borrowers, compared to other small banks that may curtail lending activities.

One approach to validating the model results is by comparing them with the banks' actual

performance. Since interest rate deregulation was only completed in 1984, insufficient time has passed to accumulate data for a comprehensive analysis. Moreover, the effects of economic recession, recovery, farm financial stress, and other factors occurring in the early 1980s have also influenced bank performance. Nonetheless, several observations can be noted, especially for variable rate pricing. Agricultural banks appear to have greatly increased their capacity to reprice loans through formal adoption of variable rates and adjustment of loan maturities. The Federal Reserve System's survey of terms of bank lending, started in 1977, indicates that the percentage of farm loans made by banks with variable rates increased from a low of 13.2 percent in May 1977 to a high of 53.5 percent in May 1983; in addition, the use of variable rates tended to be greater on larger loans and with larger banks. Similar results from a national survey indicated that 37.6 percent of agricultural banks in mid-1981 had adopted a variable rate policy for farm loans and that 46.9 percent of the banks would vary the loan maturity in loan pricing (Barry and Calvert). The use of variable rates increased significantly as bank size increased and was more common in branching and multibank holding company systems.

Little factual evidence is available about rural banks' use of other methods of responding to interest rate risk, although general impressions are that these banks have placed much emphasis on asset/liability management as a response to interest rate deregulation and other sources of uncertainty. Moreover, several other general developments have occurred. First, the liquidity positions of agricultural banks improved considerably since 1980 due to stronger deposit growth and slowdowns in loan demand, especially from financially stressed agricultural borrowers. In addition, the wide spread in interest rates on farm loans that occurred between agricultural banks and the Farm Credit System narrowed considerably following 1981 as market interest rates declined and stabilized. Nonetheless, rates have stayed far above historic levels. Finally, profitability measures indicate that agricultural banks continued to achieve relatively strong performance in the early 1980s during the initial stages of

deregulation. Rates of return on banks' equity capital in 1982 were only slightly less than during 1979 to 1981, and still in line with earnings rates during most of the 1970s (Melichar; Barry, 1984). Following 1982, however, the rates of return to equity declined sharply for these banks due primarily to higher loan losses. These higher loss rates and other costs of administering loans in part reflect the difficulties farmers and other borrowers have in dealing with higher, more volatile interest rates. Thus, while not considered in the modeling analysis, these interest rate effects from deregulation likely added to borrowers' financial problems and increased the banks' lending risks as well.

The modeling approach used here proved effective in reflecting the general financial environment, market characteristics, and risk position of an individual bank. Moreover, the approach extended other empirical analyses by jointly considering the effects of uncertainty and imperfect loan markets. However, the analysis did not explicitly consider the bank's competitive position in its local market relative to the possible responses of other banks and nonbank financial institutions. Hence an extension of the analysis to include flows of funds within the local market and among markets would be useful (Boehlje, et. al.). Also, extending the micro analysis to consider the effects of geographic liberalization, expanded product authorizations, and other regulatory changes would be timely and useful since these issues will continue to impact heavily on small rural banks.

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